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DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

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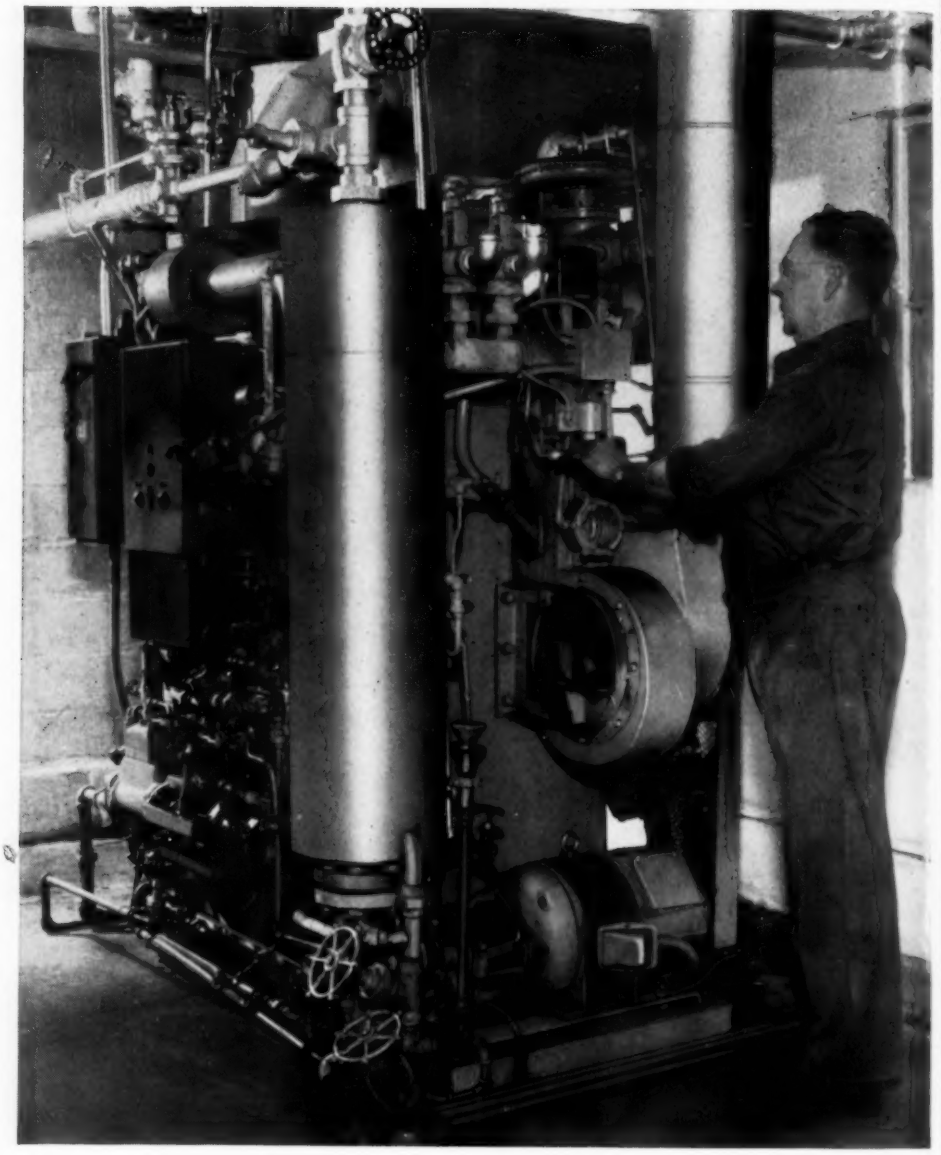
New Suwanee River Plant of Florida Power Corporation

Innovations at Mannheim Power Station ▸

Suspension Burning of Bark Refuse ▸

Lignite Burning Highlights ASME Meeting ▸



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COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

Vol. 23 **No. 4**

October 1951

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COMBUSTION publishes its annual index in the June issue and is indexed regularly by Engineering Index, Inc.

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Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Ave., New York 16
A SUBSIDIARY OF COMBUSTION ENGINEERING-SUPERHEATER INC.
Joseph V. Santry, President; Charles McDonough, Vice-President; H. H. Berry, Secretary and Treasurer

COMBUSTION is sent gratis to engineers in the U. S. A. in charge of steam plants from 500 rated boiler horsepower up and to consulting engineers in this field. To others the subscription rate, including postage, is $3 in the United States, $3.50 in Canada and Latin America and $4 in other countries. Single copies: 30 cents.
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Publication Office, Easton, Pa. Issued the middle of the month of publication.

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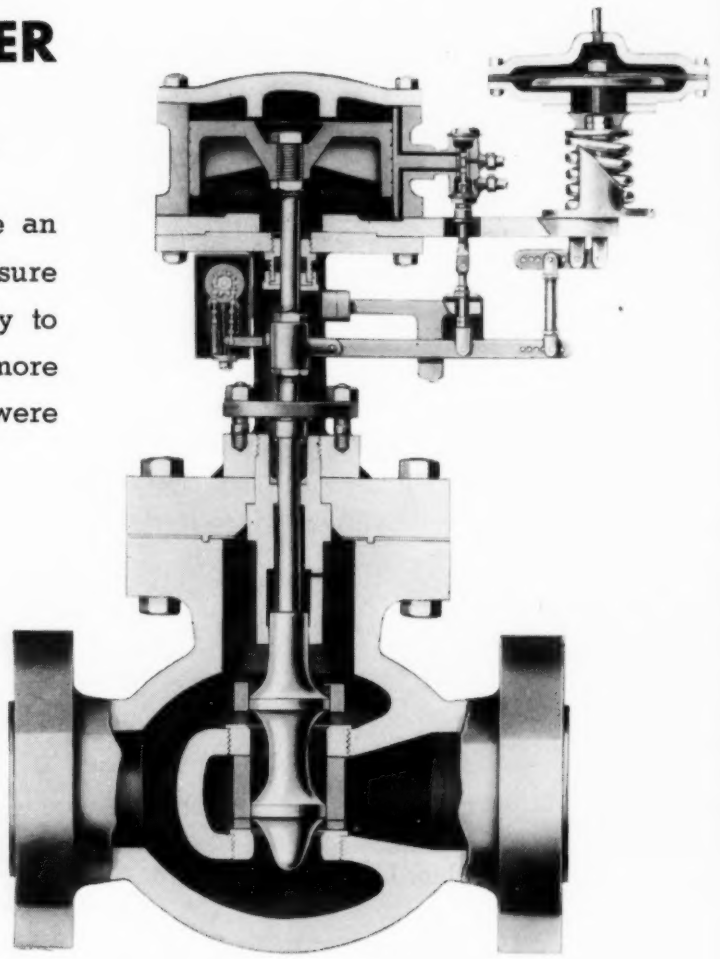

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Editorials

Will Increasing Power Demands Mean Shortages?

Speaking recently before a group of valve manufacturers, T. E. Marburger, director of the materials and equipment division of the Defense Electric Power Administration, is reported as predicting substantial power shortages in certain areas toward the end of this year or early next, which would thereafter become increasingly critical as defense production gets into full swing. This he attributed to demands increasing faster than capacity in the face of material shortages.

Unlike conditions during 1943–1944 when the production of many commodities was halted altogether, and those plant capacities given over entirely to war work, we are now attempting to maintain our civilian economy in only slightly reduced form, plus a vastly expanded military program not only for ourselves but to a considerable extent for our allies. The result has been a steadily increasing demand for electric energy which has necessitated revised estimates of requirements and resulted in the placing of further orders for some two million kilowatts additional capacity during the last six months.

By June of the present year peak loads on the utility systems had reached 60 million kilowatts, at a time when dependable capacity exceeded 69 million kilowatts; but the December 1951 aggregate peak has been estimated at $69^1/_2$ million kilowatts, by which time scheduled additions will have brought the two installed capacity to over 73 million kilowatts. This margin, however, is an average and in many sections will be much less, if indeed there will be a margin at all.

Mr. Marburger named several areas where shortages may be expected, particularly in the Northwest, despite current construction on some 630,000 kw of new capacity. To a lesser degree the Southeast shows a deficiency because of large defense plants in that region. In this connection, it is significant that the Office of Defense Mobilization has suggested relocation of some large power-consuming defense projects, such as certain aluminum plants.

Such delays in deliveries as have occurred to date have been attributable largely to the materials situation rather than to inadequate planning or lack of equipment manufacturing capacity, although in a few individual cases labor disputes have been responsible for short delays in completing installations.

It is generally accepted that reserves will be lower than was previously anticipated, but if past experiences may serve as a criterion, the ingenuity of electric utility engineers, plus consumer cooperation, can be counted upon to minimize such inconveniences as may occur, except perhaps in a few areas. However, by the latter part of next year it is anticipated that much of the increasing defense load will have been taken over by power plants now under construction to serve large individual projects.

Steam-Turbine Locomotives

An editorial in the August 24 issue of *The Railway Gazette* (London) calls attention to the succession of steam-turbine locomotives that have been tried over the past forty-five years in a number of countries throughout the world. Although this form of railroad motive power affords much promise from a theoretical point of view, one is inclined to agree with this conclusion of the editorial writer: "Few experimental realms in steam locomotive design can have been explored with more persistence and less ultimate success than that of steam-turbine propulsion."

In view of the almost complete displacement of the reciprocating steam engine by the turbine in steam-powered stationary plants, it may seem surprising that the turbine has had such little success on the railroad. But then it should be remembered that, with several notable exceptions, the water-tube boiler has not been widely accepted for locomotive use; hence steam pressures are low compared to stationary practice, and the condensing cycle is inapplicable for good reasons. Also, the amount of power required, the high initial starting torque and the extreme fluctuations in demand place the locomotive power plant in an entirely different category from the large central station where the condensing steam cycle is now employed at its highest thermal efficiency.

Efforts in the past have been made by some of the most competent turbine builders in this country and abroad to apply the steam turbine to locomotive service. Likewise, motive power departments from such outstanding railways as the Pennsylvania, Union Pacific and Chesapeake & Ohio in this country and the former London, Midland & Scottish in Great Britain have made major investments in this form of propulsion without developing a locomotive that is both economical to operate and practical for everyday railroad service.

At the present time it appears that only the gas turbine holds much promise as a nonreciprocating type of locomotive power plant. Whether it will have wider and more successful application than the steam turbine in locomotive service remains to be seen.

Some Innovations at Mannheim Power Station, Germany

By DR. F. MARGUERRE*

This well-known high-pressure German power station has lately been extended by the addition of two topping turbines and four steam generating units. Innovations include channel-type superheaters, fan turbine in series with steam supply to main unit, a novel arrangement of steam reheat and a unique system of mill drying with a bin-and-feeder system.

AS EARLY as 1928 the Mannheim power station installed steam generators and turbines working at 1560 psi and 878 F. Today, twenty-three years later, these steam generators are still in operation, their superheaters having been changed to provide a steam temperature of 914 F. Lately, four new steam generating units each designed for an output of 310,000 lb per hr at 1820 psi and 932 F, as well as two 32,000-kw topping turbines were installed. The recent units employ some innovations which are described in the following notes.

The first of these innovations concerns the method of steam reheating which offers certain operating and economic advantages. The arrangement adopted leads to the employment of only one enlarged superheater. Let us first examine its design.

It is known that the design of a steam generator for high superheat has to meet two opposing requirements: One is a high furnace in order to cool down the exit gases below the ash-fusion point and the other is to provide sufficiently high gas temperatures at exit to give the desired superheat. To place the superheater tubes directly on the furnace walls involves certain objections, especially because of the high heat transfer concentrated on one side of the tube and the difficulties encountered at partial loads. These objections were met by the use of "channel" superheaters (Fig. 1) which were introduced for the first time by the KSG[1] thirteen years ago. This type of superheater has been used in Germany for a considerable number of units and is now also being taken up abroad.

The basic idea is to suspend the radiation section of the superheater in the upper part of the furnace in flat panels with spacings wide enough to preclude any bridging of slag. To compensate for any unequal distribution of the fire in the furnace cross-section, the superheater loops are inter-connected in such a manner that each traverses both halves of the furnace. In addition, the broad channels provide considerable depth for a sufficient amount of radiation and yet avoid the dangers which could be encountered in the highest temperature sections of the furnace.

The design has had a splendid record in this installation as well as in many other units where it was employed. It provides a very stable temperature with varying loads, has never run into slagging difficulties, nor shown dangerous tube temperatures at loads down to 30 per cent.

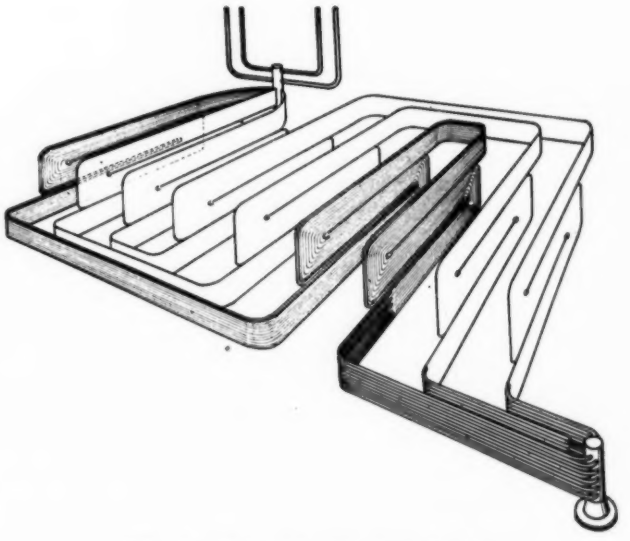

Fig. 1—Channel-type superheater

Reheat Arrangement

The special reheat arrangement is shown schematically in Fig. 2. After leaving the drum (*1*) the steam first enters the primary section of the superheater (*2*) and is here heated to a temperature determined by the contemplated reheat. It then continues on to a heat-exchanger (*5*), located directly under the topping turbine (*4*). There the steam gives up part of its superheat and returns to the secondary superheater (*3*) where it is brought up to the desired final superheat temperature.

This arrangement is also combined with a temperature control scheme. It is known that temperature control can be attained by leading part of the steam through a desuperheater located inside the steam drum of the unit. At high pressures, however, this arrangement has some disadvantages. In addition to problems of design, which nevertheless can be successfully overcome, the very limited space available inside the drum considerably re-

*Director General of the Mannheim Power Station until retirement on July 1, 1951.

[1] Kohlenscheidungs-Gesellschaft, formerly of Berlin but now located in Stuttgart, Germany.

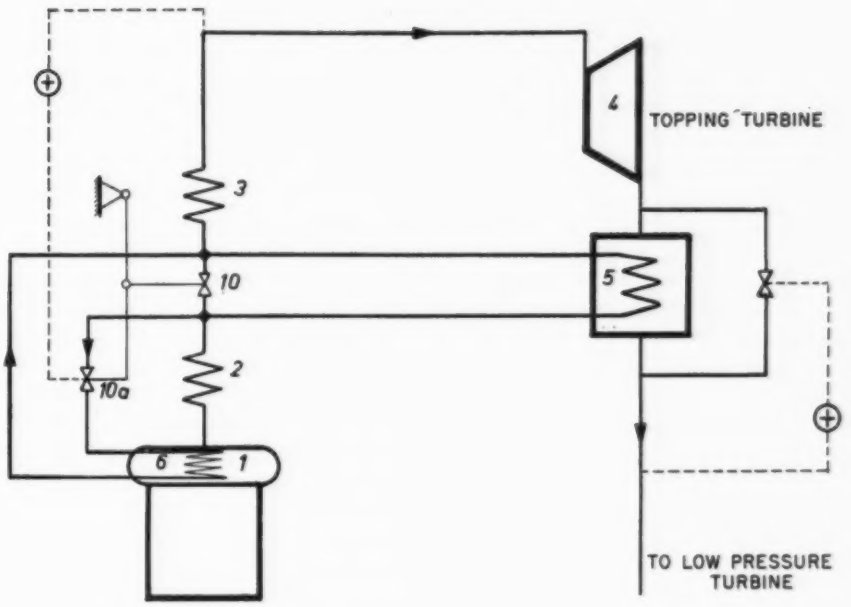

Fig. 2—Arrangement of steam reheater. For simplicity in this sketch the series fan turbine, between the two superheater sections, has been omitted

stricts the amount of cooling surface. However, if the desuperheater (*6*), is connected in parallel with the heat exchanger (*5*), a considerable pressure drop becomes available which can very well be used for high steam velocities. In this manner the desuperheater can be made small and fit easily into the drum despite its relatively large heat-absorbing capacity.

The ability to reheat with only part of the primary superheated steam is due to the fact that the specific heat of the steam at very high pressures is considerably greater than at medium pressures. Furthermore, the reheat steam flow is less than the primary flow when high feedwater heating is employed. Calculations and experience show that a far-reaching temperature control is possible without interference with the reheat process. This even goes so far as to permit absorption of all heat in the desuperheater should the reheater be out of service, for if necessary the unit can be operated without reheat. The temperature is controlled by valve (*10a*) which is piloted by the final steam temperature and the short-circuit valve (*10*) operated in countermovement to valve (*10a*), to avoid changing the steam flow to the heat-exchanger. Reheating is therefore independent of the superheat temperature control, but can be influenced by a bypass, as necessary.

The heat-exchanger, which is arranged directly beneath the topping turbine, has a very small steam volume; in fact, about one-tenth of that encountered in a normal flue-gas reheater including piping. Experience and calculations show that control is simplified to an extent which removes all possible arguments against use of reheat, and makes the special safety features usually employed unnecessary.

Because of the short connections of the low-pressure steam circuit and the small heating surface due to a favorable heat transfer on both sides of the heat-exchanger, the pressure drop and thermodynamic loss at 280 to 350 psi—a range of high turbine efficiency—is reduced considerably to 7 psi as against the usual 35 to 42 psi. In addition, the large piping normally required for medium pressures has been replaced by small-diameter pipe for high-pressure steam. This not only saves considerable space but eliminates any reason for not using the thermodynamically most favorable reheat pressure. It should also be pointed out that if the superheater shows a flat temperature load curve—which the channel superheater arrangement in Mannheim does—this same characteristic is automatically imposed on the reheat performance.

The space arrangement of the superheaters at Mannheim is indicated in Fig. 3. Here it will be noted that the low-temperature conventional elements of both the primary and secondary superheaters are followed by channel-type radiant sections. Also, the turbine indicated at the left is the series fan-drive turbine which is described later.

It may now be questioned whether the indirect reheat system increases initial costs. First, it should be considered that the low pressure drop in the heat-exchanger (reheater) takes place in a high efficiency range of the

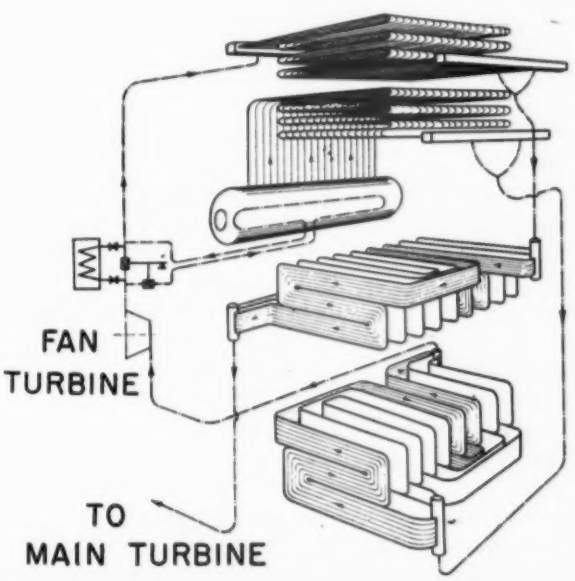

Fig. 3—Arrangement of Mannheim superheaters

turbine and is responsible for an improvement of about $1^1/_2$ per cent in the heat rate. This gain is by no means compensated by the somewhat larger pressure drop on the high pressure side, especially since the steam is again superheated. A profit of $1^1/_2$ per cent, however, means a saving of $1^1/_2$ per cent in the initial investment for the total plant.

While the superheater requires a little more heating surface, there now is no need for additional reheater headers which would otherwise take up space in the boiler. The high-pressure piping to the reheater also requires much less space in the boiler and turbine house than does the usual low-pressure piping. In addition, certain safety devices needed on account of the large steam volume in the reheat system are unnecessary. The desuperheater in the drum is cheaper than the usual spray desuperheater, yet has all the advantages that go with the surface-type unit. The heat-exchanger itself is of completely welded construction and costs approximately $1^1/_2$ per cent of the steam generator price. All this adds up to a higher efficiency at no additional total cost per net kilowatt.

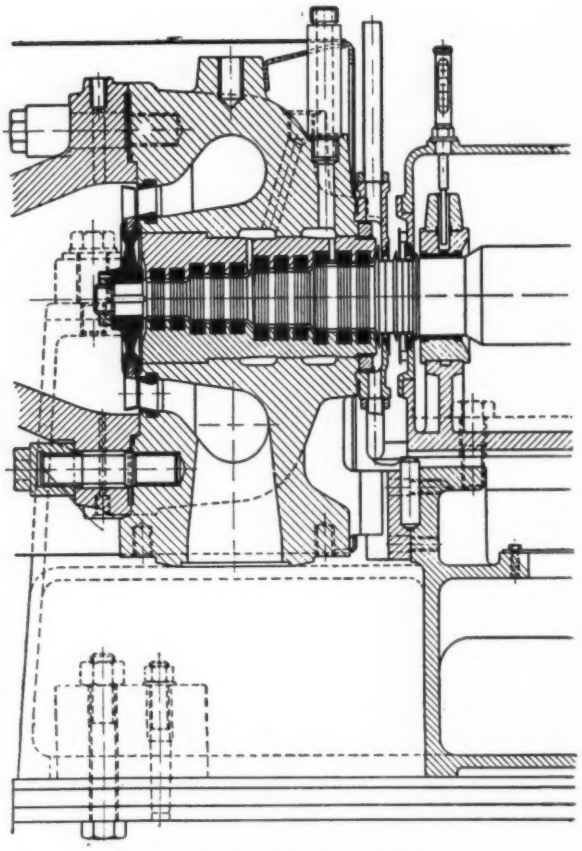

Fig. 4—Section through fan turbine

The one disadvantage is in the fact that reheat temperatures are 85 to 95 deg F below the highest superheat temperature. However, if the highest temperature is considered as being limited by the turbine and the steam generator is capable of somewhat higher temperatures, then by this arrangement the reheat temperature can be brought to the same level as the superheat steam temperature at the turbine throttle.

Another unusual arrangement at Mannheim is the fan drive by a self-regulating fan turbine. This is a single-stage machine which uses the total steam flow from the boiler with a pressure drop sufficient to give the necessary power for driving the fans. The turbine has the characteristic of changing its output in accordance with the cube of the steam flow from the boiler. Since the required fan power also increases with the cube of the air flow, the proper ratio is maintained for every load once the turbine has been adjusted for any one load. In other words, this means that the steam generator does not need any control of air flow whatsoever. In addition, the turbine speed, and with it that of the fan, balances itself automatically in proportion to the steam flow. Thus the ratio of the steam velocity to rotor velocity remains constant at all loads and the turbine always operates with highest efficiency. The same is equally true for the fans, which now are completely speed controlled, thus eliminating any damping losses.

The arrangement of the turbine in series with the steam flow can be seen in Fig. 3 at the left side just below the heat-exchanger. The turbine is arranged between the two superheating elements and therefore does not work with the highest steam temperature. The thermodynamic efficiency is very favorable, using simple back-pressure operation. With the usual fan power requirements of about $1^1/_2$ per cent, the overall power plant efficiency per net output is thus increased as much as raising the steam temperature by 75 to 85 deg F would achieve.

The forced- and induced-draft fans can be arranged on one shaft and driven directly by the series turbine. This is the cheapest arrangement. If this is not feasible because of air duct location, the induced-draft fan may be driven directly and the forced-draft fan electrically. This offers little difficulty since a motor is necessary anyway for starting up because the fan turbine cannot work until the steam generator is in operation.

Investment cost of this arrangement is lower than that for electric drive, if the loss of net electrical output connected with the usual electric drive is taken into account.

The oldest turbine of this type at Mannheim has been in operation for fifteen years; two others for five and six years, respectively, and four more such machines were started recently. They use partly mechanical and partly electrical transmissions. After initial difficulties the availability of the turbines has been most satisfying. It can be considered an additional advantage that the starter motor when installed large enough can act as a reserve drive should the turbine actually fail. In such a case, the turbine would be cut out by two gate valves and bypassed.

This bypass can also be used for adjusting the air volume. It should be here noted that bypassing of 5 per cent of the steam causes a decrease in turbine output of 15 per cent. Regulation of the bypass either by hand or automatically allows adjustment of necessary draft to the dirtiness of the steam generating unit.

All in all, the feature provides a cheaper arrangement for larger units, an ideal air control without any apparatus and improved efficiency at all loads. Fig. 4 is a cross-section of the turbine.

Still another innovation deals with the drying of coal in the mills when using a bin-and-feeder system. Practical experience with this special arrangement, which allows all pulverizing to be done at night, shows that a steam generator with a maximum output of approxi-

mately 310,000 lb per hr can operate during the night at 90,000 to 100,000 lb per hr load while at the same time 45,000 lb of coal are being pulverized. Despite a low content of 11 per cent volatile matter, no flame instability is experienced. Coal with higher volatile would afford the same high pulverizing output at even lower evaporation. It may be pointed out that by this arrangement about $1^1/_2$ per cent of the plant output that is needed for pulverizing is additionally available during daytime, a fact which reduces the total initial cost per net output.

Mill Drying

The arrangement of mill drying with a bin-and-feeder system, as generally employed in Europe, is shown in Fig. 5 while Fig. 6 shows that selected for the Mannheim power station. In the usual arrangement hot flue gases are drawn from the steam generating unit somewhere between the superheater and economizer into the pulverizer (*b*), while the raw coal is added at the mill entrance (*a*). The coal gas mixture leaving the mill goes to the cyclone (*c*) which separates most of the pulverized coal. A fan (*d*) blows the vented gas into the furnace (*F*) where the rest of the pulverized coal is burned. It can be seen from this diagram that the heat for coal drying is taken from the boiler in a high gas temperature zone

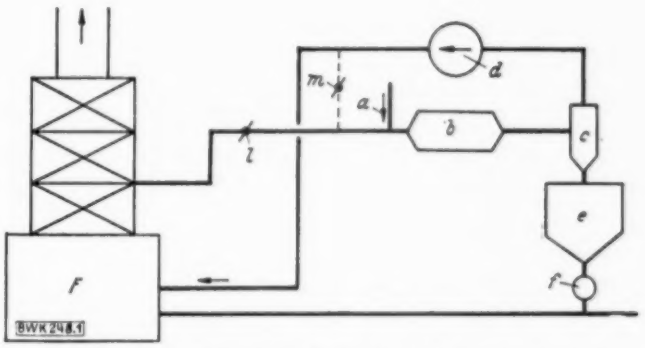

Fig. 5—Usual European bin-and-feeder arrangement

(*c*). The vented gas is then carried by a fan (*d*) to the heater (*h*) which it leaves at about 608 F. This temperature was selected to avoid any degassing of the circulating pulverized coal. Most of this gas is then returned to the pulverizer while a small partial flow, containing only as much water vapor as is simultaneously driven from the coal, passes damper (*q*) and is blown into the furnace by fan (*i*).

If the lowest gas temperature in the mill-drying circuit reaches 212 F, hot flue gas will be added by way of damper (*p*) and vented again at (*q*) in order to avoid falling below the dew point. As long as the temperature remains above 212 F everywhere in the drying circuit, no additional flue gases are needed. Drying is then accomplished purely with superheated steam. The gas entering the furnace by way of (*q*) is reduced to 10 per cent of the otherwise encountered volume. (It is also contemplated to condense the steam in a feedwater heater to regain the heat of evaporation.) In all cases, the influence on the furnace is so light as to use the pulverizers to full capacity at lowest evaporation and shut them down for many hours during maximum load. In this way the available electric output is increased by 1 to 1.5 per cent which as capital value by far outweighs the additional cost of the new equipment, itself about 1 per cent of the steam generator price.

Heating of the heat-exchanger by a partial gas flow

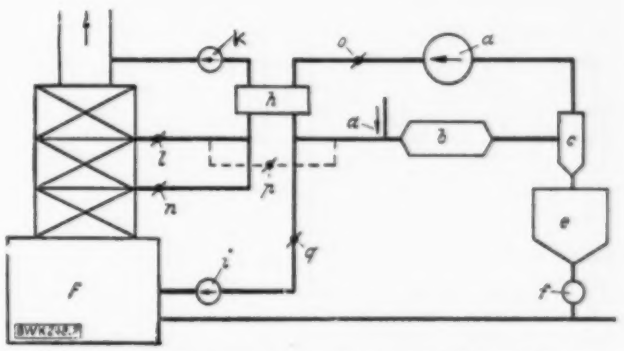

Fig. 6—Bin-and-feeder arrangement at Mannheim

and that the combustion gas flow from the furnace to the superheater is loaded with a large circulating flow of cold gas. Temperatures in this range are then lowered and larger free gas area and heating surface made necessary. A drop in furnace temperature also aggravates combustion conditions and makes it impossible to fully operate the pulverizers at partial boiler loads. Using heated air for drying instead of hot gas merely eliminates the circulation of inert gases, but retains the other disadvantages.

Instead of closing the mill drying circuit by way of heating surfaces in the steam generating unit, the new arrangement at Mannheim (Fig. 6) uses a vent-gas heater (*h*) as an additional heat-exchanger indirectly heated by part of the flue gases. This leads to the double advantage of keeping the cold inert gases away from the boiler and of achieving a somewhat lower exit gas temperature with the same amount of heating surface. In this arrangement fuel is also added at (*a*) and the gas-coal mixture from the pulverizer (*b*) leads into the cyclone which is taken either ahead of the air preheater or ahead of the economizer, can be regulated by dampers (*l*) and (*n*) in response to load and coal moisture and can be augmented by fan (*k*) at low loads. Lowering of the average exit gas temperature through additional cooling increases boiler efficiency by 1 per cent already at 10 per cent moisture in the fuel and this alone suffices to compensate the added equipment costs within one to two years—not considering all other advantages mentioned above.

The pulverizer plant is centrally controlled by registering fans, dampers and operating data. Dampers (*l*) and (*n*) control the temperatures, (*p*) and (*q*) the moisture and pressure and (*o*) the flow in the drying circuit. The bin (*c*) is subdivided and fitted with an exit to each furnace corner so that the pulverized coal falls toward the burners. Primary fans with their undesirable coal piping are thus eliminated.

The arrangements described here are all in operation at the present time.

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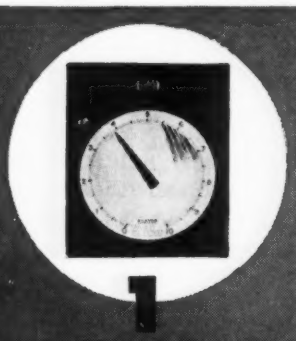

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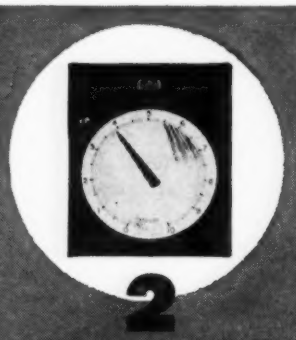

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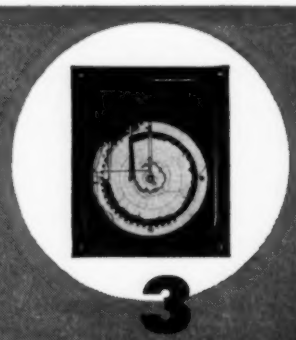


3

HAYS COMBUSTION METER

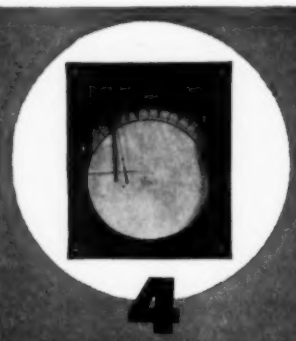
Hundreds of these meters have been in operation for many years in all types of plants burning all kinds of fuels and saving thousands of fuel dollars.

PRINCIPLE

Operates on Orsat principle of Volumetric measurement and chemical absorption. Extremely simple: sample of flue gas trapped and accurately measured; passed through chemical which removes CO_2 component of gas mixture. Sample is re-measured, volume compared to original sample. Difference before and after absorption gives exact percentage of CO_2 absorbed by chemical.

FEATURES

- Low price
- Water operation
- Pressure and temp. compensated
- Volumetric determination
- Chemical absorption
- 2 minute operating cycle
- Easily understood
- Rugged construction
- Low maintenance
- Available in 6 remote mounted types and 3 integral types
- Remote or integral mounting
- 10" 24-hour chart
- Available for: (a) CO_2 only—recording with or without indicator (b) CO_2 and flue gas temperature recorder combined (c) CO_2, draft or flue gas temperature recorder combined



4

HAYS-PENN BOILER EFFICIENCY METER

Provides a QUANTITATIVE guide to efficiency — deals with quantities of air and steam; by contrast CO_2 and O_2 meters are QUALITATIVE guides since they determine directly quality of combustion gases. Both Boiler Efficiency Meter and Gas Analysis Meter are used to obtain advantages of both methods.

PRINCIPLE

Pounds of air required to burn each pound of coal vary widely with heating value of coal; constant weight of air is required to produce same Btu. Similar relationship exists when oil and natural gas are used as fuels. Record of steam flow is assumed to be Btu's produced; record of air flow is calibrated to flow of air required to generate that steam.

FEATURES

- Electric operation of flow meter and air flow recorder
- Diaphragm type air flow measuring unit
- Air flow measuring element does no work
- Air flow recorder—motor operated
- Adjustable cam air flow calibration
- Mercury transmitter—pressures to 2500 psi
- Interchangeable range tubes for steam flow
- Remote mounted steam flow transmitter
- No high pressure piping into panel
- Easily installed and adjusted
- Low maintenance

THE **HAYS** CORPORATION

MICHIGAN CITY 1, INDIANA

Automatic Combustion Control • Boiler Panels • Hays-Penn Flowmeters Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages Combustion Test Sets • CO_2 Recorders • Electronic Oxygen Recorders

Suspension Burning of Bark Refuse

Digest of a paper presented by R. Ellwanger, chief engineer, The Chesapeake Corporation of Virginia, before the Technical Association of the Pulp and Paper Industry at Richmond, Va., on September 25, in which is described an installation designed for suspension burning of bark refuse with high-set spreaders and employment of extreme turbulence. Performance has been excellent and availability exceptionally high.

GUIDED by experience with the pioneer development of a high-set spreader stoker and traveling-grate burning spent wood chips at a southern chemical plant, the new Chesapeake Corporation installation was designed to incorporate a steam generating unit rated at 90,000 lb per hr continuous steaming capacity, with sufficient excess fan capacity to develop 150,000 lb per hr, and having a similar setting for burning wood refuse.

This by-product fuel has a moisture content ranging from 30 to 50 per cent, a volatile content around 75 per cent, ash about $1^1/_2$ per cent and an average heat content of 9260 Btu per lb. It is hogged by two $13^1/_2$-ton machines of the high-speed rotating-cylinder knife type in order to afford the desired size reduction for suspension burning. One of these hogging machines is sufficient for winter requirements, but both are necessary in late spring and summer when the bark is sappy. The conveying system which incorporates an electro-magnet ahead of the hoggers, is laid out to handle coal as an alternate fuel, if this should become desirable. A sequential electrical interlocking system has been fitted to the conveyors. Provision has also been made for burning oil during off-period operation.

Spreaders High Set

The steam generating unit, which is of two-drum design as indicated in Fig. 1, has a completely water-cooled furnace with short arches at the front and rear, and the ash discharge from the stoker is at the front. The four high-set spreader units are mounted 17 ft above the traveling grate and the average distance from grate to roof tubes is 44 ft.

Air for combustion, at 500 to 550 F from the tubular air preheater, is introduced through seven rows of tangential nozzles, or jets, in each side wall, the direction of rotation being reversed in alternate rows. The side walls account for 28 air jets in addition to which there are 21 jets under the rear arch and a like number in the upper rear wall 13 ft above the grate. The effect of the component forces of these numerous jets is to fill the furnace completely with a rapidly swirling gas mass. That portion of the bark not burned in suspension (probably about 15 per cent) is distributed relatively uniformly over the entire grate surface.

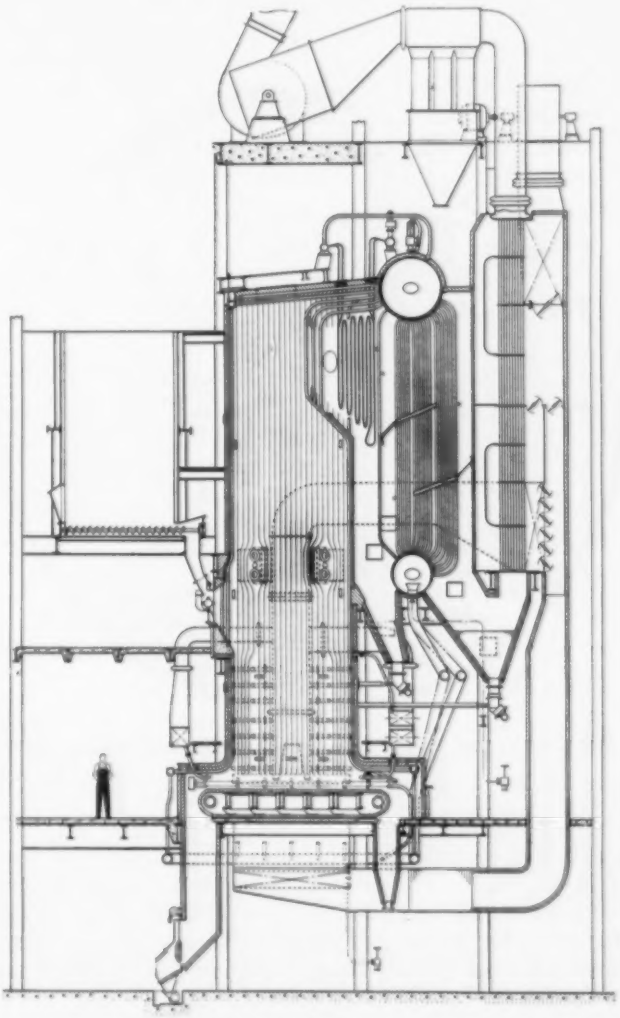


Fig. 1—Section through C-E high-set spreader-fired boiler with traveling grate and numerous air jets

Four oil burners are placed in each side wall with an air jet located between each group of two burners. The rear wall jets, as well as those between the oil burners,

are used as required for air supply and to produce turbulence.

An outstanding characteristic of such suspension burning is the ultra-fast responsiveness to load changes.

A cinder recovery and reinjection system is provided as shown in the cross-section. This incorporates steammatic exhausters, one in each side wall above the grate for reinjection from the multi-tubular dust collector hoppers and four for reinjection from the four-pass hoppers. All six discharge into an area of low turbulence where the unburned carbon is effectively deposited on the grate and the entrained sand is carried forward by the grate to the ash pit. This sand remains on the grate because of the low velocity of forced draft under the stoker, the major portion of combustion air being handled by the jets. Tests at 130,000 lb of steam per hour have shown a dust loading to the stack as low as 0.306 grains per cu ft.

Operating Results

As of August 1, the unit had operated a total of 4412 hr out of a possible 4688 hr from January 15, 1951, at which time it was first placed in service. During this period there were three outages, all scheduled except one,

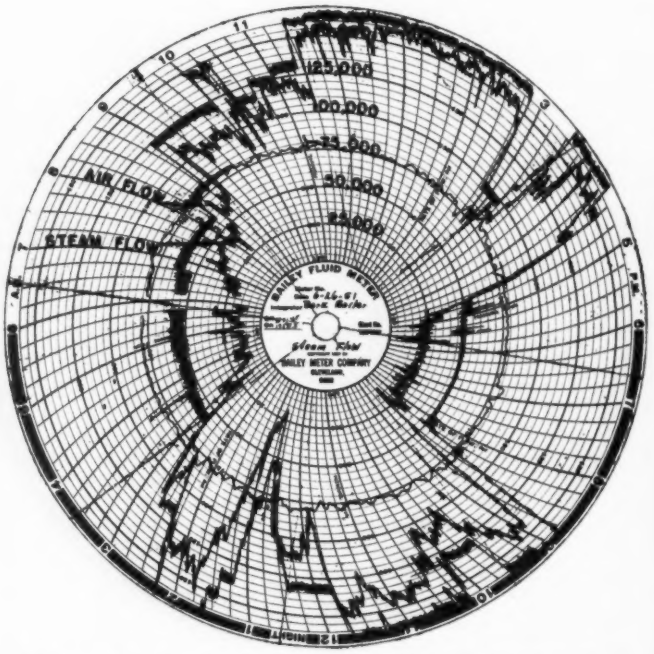


Fig. 2—Typical steam-flow, air-flow chart showing rapid load swings

which was necessitated by failure of the magnetic coupling bearings. Except for these three instances, the availability has been better than 99 per cent. Boiler efficiency, by difference, figures 78.7 per cent, as compared with the guarantee of 75 per cent at 90,000 lb per hr output.

The unit has often operated at 160,000 lb per hr for several hours, at which load the heat release has been 38,000 Btu per cu ft per hr. A typical steam-flow chart covering extreme load variations from 10,000 lb per hr to 160,000 lb per hr with a $3^1/_2$ hr run at an average corrected steam flow of 154,000 lb per hr is shown in Fig. 2.

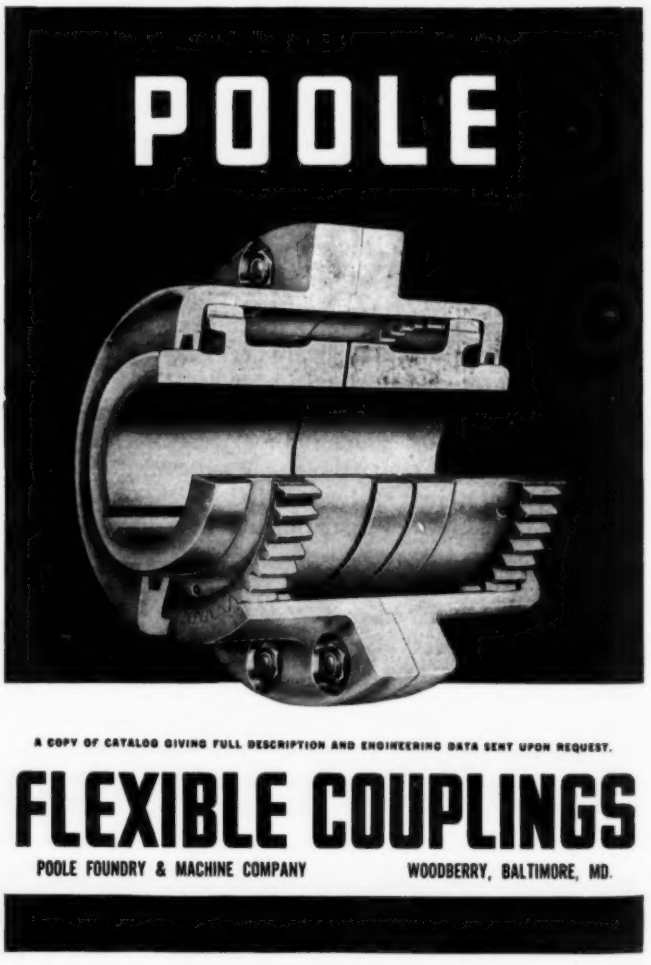
Several performance tests have indicated the total carbon loss to the stack and ashpit to be of the magnitude of one per cent. This is attributed principally to the design of the furnace and jets, as well as to the efficiency of the reinjection system.

It is noted that after $6^1/_2$ months of continuous operation there is no observable sand erosion or cutting on the boiler heating surfaces.

Conclusions

In conclusion, the author states: "The savings in fuel cost in this installation represent the major portion of financial return on invested capital. The reduction in direct operating labor resulting from the incorporation of the bark boiler into our main power plant building, as well as the elimination of maintenance on refractory settings and water-cooled grates, has likewise effected an appreciable saving. Even with the increased cost of additional kilowatt input for auxilaries, the maintenance cost of the hoggers, and the additional steam used by the fly-ash reinjection system, the bark boiler installation is yielding an attractive return on our investment."

"Additional attractive yearly savings could be effected by providing outside storage capacity and thereby permit base loading of the unit to reduce the extreme high and low operating levels. The ability of the boiler installation, however, to support easily a much higher level of pulp production is, in itself, a factor to be weighed heavily when a financial analysis of the installation is involved."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Lignite Burning Highlights ASME Fall Meeting

More than 500 mechanical engineers were present for the ASME Fall Meeting held at the Hotel Radisson, Minneapolis, Minn., on Sept. 26–28. One of the most enthusiastically received features of the meeting was a series of papers on the utilization of lignite, which is assuming great importance in the Northern Great Plains Province of the United States and Canada.

At the President's Luncheon, Warren C. MacFarlane, president of the Minneapolis-Moline Co., directed his remarks toward the theme of the meeting, "Engineering Problems Common to Industry and Agriculture." He pointed out that the character of economic activity in the Twin Cities region had changed so that what once was an area almost entirely dependent upon agriculture had within the past thirty years become

J. Calvin Brown, president of ASME, presiding at President's Luncheon

a well integrated combination of industrial and agricultural activities.

The Calvin W. Rice Lecture was delivered by Dr. Frederick Oederlin, managing director of Sulzer Brothers, Ltd., who detailed many of the accomplishments of the Swiss mechanical engineering industry. There are 120,000 workers in this segment of industry, or 25 per cent of the factory workers of all groups. Of the output, exports account for 50 to 75 per cent of the total production. Dr. Oederlin mentioned the development of air compressors capable of delivering 5000 cfm at 15,000 psig, the first gas-turbine stationary and locomotive installations, and the Velox and the Monotube steam generators. An experimental unit of the latter design has been built for steam conditions of 1110 F and 2300 psig. He also told of two projected pumps each having a power requirement of 80,000 bhp. Paying tribute to the Swiss workmen, he described them as hard-working, conscientious people who still regard high class work as a point of honor.

At the Junior Conference, Fred T. Agthe of Allis-Chalmers Mfg. Co., speaking on "A Current Plan for Young Engineers," urged that the study of economics should be continued during the first postgraduate years, so that those starting careers would realize the role that economic forces play in all engineering operations. Leisure time should be invested wisely so that habits may be cultivated which lead to systematic professional development. While participation in community affairs is important, for the first few years there are likely to be prior interests in professional self-development and in creating a happy family life that should receive first consideration.

Speaking at the Banquet on Sept. 27, J. Calvin Brown, president of ASME, declared that while technical revolution has in one sense set men free or given them new hope of freedom, it also threatens mankind with new forms of enslavement. Many of the great problems of our time have arisen from the violent impact of technology on the institutions and beliefs of mankind. One of the achievements of the American system has been its ability to absorb and even to encourage the technical revolution without forfeiting its own basic characteristics.

Utilization of Lignite

"Operation of Large Power Boilers with Lignite Coals from the Dominion of Canada and Northern United States" was the title of a paper by **J. W. Hoffman** of Northern States Power Co. and **John M. Drabelle** of Iowa Electric Light & Power Co. This dealt largely with spreader-stoker firing and is abstracted at some length elsewhere in this issue.

Leopold Pistner of Fuel Economy Engineering Co. was the author of a paper entitled "Basic Elements of Design and Operation of Steam Generating Units for the Utilization of North Dakota Lignite." It was his belief that direct utilization without pre-preparation represents the method whereby lignite can be utilized most economically in terms of fuel cost per kilowatt hour.

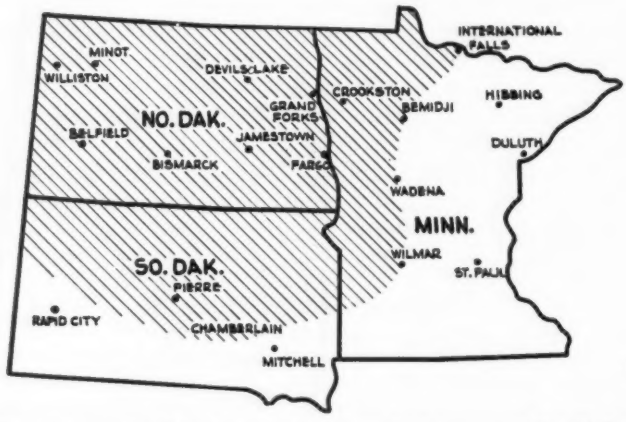
The three methods of lignite burning which are in general use are (1) forced-draft zoned traveling-grate stokers, (2) spreader stokers, and (3) unit-type pulverized-coal firing.

At the present time there are between 40 and 50 traveling-grate stokers which have given generally satisfactory service for the last 15 to 20 years. Some of the more recent installations have been equipped with air preheaters for air temperatures of between 400 and 450 F. These temperatures have added to the stability and speed of ignition and have enabled the use of combustion rates in excess of those considered feasible in the early stages of the work. The installation at the Washburn Station of Otter Tail Power Co. has operated at

coal rates as high as 80 lb per sq ft of grate surface per hour and at heat rates on the order of 500,000 Btu per sq ft of projected grate surface per hour.

Overfire air has been used to an increasing degree as a supplementary device for improving the efficiency of mixing of the extremely long-flame lignites. The use of cold air for this purpose has been unsatisfactory, and most of the installations have used secondary blowers which secure their supply from the main preheated air-duct system and deliver it to the furnace at static pressures between 20 and 25 in. Overfire air may amount to 10 to 15 per cent of the total combustion air. However, the furnace design itself must provide the necessary mixing action of oxygen, carbon particles and hydrocarbon gases, supplemented by the effect of the overfire air.

Mr. Pistner described an interesting development known as the radiant air preheater, which is essentially a section of air-preheater surface composed of tubes exposed within the furnace limits. The air passes through the tubes, which are located in positions similar to front water walls, and the radiant air preheater absorbs heat



Present geographical area of economical usage of lignite as a fuel

by radiation from the flame. Temperatures as high as 1000 F have been obtained, and higher temperatures are possible. The admission of this highly preheated air directly into the incoming fuel bed creates instantaneous ignition, and it is believed that the maximum burning rate might be materially increased because a portion of the grate would no longer be required for preliminary drying and ignition.

Regarding firing of lignite in pulverized form, the author pointed out that overall steam-generating efficiencies would be about two points higher than with spreader stoker practice, assuming the same exit gas temperature in each case. In practice the ability to respond to load swings with external control of air-fuel ratios independent of fuel quality permits this differential to be increased. In addition, the pulverized fuel installation does not lose efficiency as a result of nonuniform sizing and improper preparation of fuel delivered from the mine.

In a paper entitled "Steam Generating Unit Designs for Burning Coals from the Northern Great Plains Province" **John H. Cruise** and **Otto de Lorenzi** of Combustion Engineering-Superheater, Inc., placed major emphasis on the application of chain- and traveling-grate stokers for burning lignite and subbituminous. Their paper also discussed fuel characteristics of the Northern Great Plains Province as well as the use of underfeed stokers, spreader stokers, and pulverized fuel.[1]

Until about 1922 the natural-draft type of chain-grate stokers was widely used for free-burning fuels, including those having high moisture content and severe weathering characteristics. Furnaces of the front-arch type were generally used with the natural-draft stokers. Efforts to burn lignite on forced-draft stokers installed in front-arch furnaces did not prove to be very successful. In 1928 two identical boilers were installed at Mobridge, S. Dak., one equipped with a forced-draft traveling-grate stoker set in a combination-arch furnace and the other with the same type of stoker in a rear-arch furnace. Tests showed practically no efficiency difference below a grate liberation of 275,000 Btu per sq ft per hr and an advantage of more than 10 per cent for the rear-arch design at a liberation rate of 350,000 Btu per sq ft per hr.

The latest type of rear-arch design is represented by a unit installed in the Estevan Steam Plant of the Saskatchewan Power Commission where Souris lignite bug dust is the fuel. The long, low arch is of the water-cooled refractory type and the furnace front wall is completely water-cooled with fin tubes which have a refractory covering over the lower 15 per cent. Designed for a maximum steam capacity of 80,000 lb per hr, the unit demonstrated that it could easily be operated at rates in excess of guarantees. The results of a test at 86,000 lb per hr show an efficiency of 73.7 per cent adjusted to 500 F exit gas temperature with a corresponding grate liberation rate of 336,000 Btu per sq ft per hr.

The performance of the Estevan units has demonstrated that where traveling-grate stokers are used the rear-arch furnace assures satisfactory operation with low-rank fuel. The fully ignited and active fuel bed contrasts sharply with the darkened front drying zone so typical of the combination-arch furnace. High velocity flow of gas from under the rear arch produces a rolling turbulence which promotes rapid moisture evaporation, stabilizes ignition, eliminates stratification, and assures uniform composition of gas entering the boiler surfaces.

For units up to approximately 200,000 lb per hr either traveling-grate or spreader stokers may be selected. In the range starting from 75,000 lb per hr, pulverized-coal firing should receive careful consideration. One advantage of the latter is the ease of switching to other fuels, a factor of significance now that North and South Dakota are in the ranks of petroleum producing states.

Discussion

The three papers on design and operation of steam generating units for burning lignite showed conclusively that lignite can be effectively used without pre-preparation. It was pointed out that the burning

[1] This paper will appear in more complete form in a future issue of COMBUSTION.

characteristics of lignite, even from the same mine, may vary significantly from day to day and under different load conditions. The type of personnel available for operation may have an important bearing on the selection of firing methods. One engineer regarded the chain-grate stoker as requiring the least degree of operating skill and the spreader stoker the highest, with pulverized-fuel firing in an intermediate position.

A strong case was made for the use of conservative heat releases in the burning of lignite. Though much higher rates were mentioned in the papers, one utility company engineer advocated staying within the range of 18,000 to 19,000 Btu per cu ft per hr.

There was considerable disagreement as to the relative merits of combination arches and long-rear arches in traveling-grate installations. The part that over-fire air plays in improving combustion was mentioned, one engineer contending that it is merely a case of making the rear arch more efficient and another arguing that over-fire air makes possible better control than with the rear arch alone.

To obtain better control of spreader stokers zoning was advocated. For units operating over an exceptionally wide load range, the rear-discharge spreader stoker was claimed to have advantages. Considerable interest was expressed in the high-set spreader stoker mentioned during Mr. de Lorenzi's presentation. Mention was made of a dumping-grate spreader stoker burning Canadian lignite and equipped with a secondary ash-pit shut-off louver.

With pulverized-lignite firing it was pointed out that the pulverizer must be capable of drying lignite to 25 per cent or less and still maintain a temperature above 140 F at discharge. Ignition at this moisture level is as satisfactory with lignite as is the case with pulverized bituminous coal.

Lignite Research

A report on current research on lignite was presented by **Alex C. Burr,** chief of the fuels technology division of Region V, U. S. Bureau of Mines. Interest in the mining and utilization of lignite extends to England, where production of 500 tons per day is reported in one seam; to France, where a study has recently been published by the Ministry of Mines; to Greece and Turkey, in both of which countries it is being investigated as a fuel source for power plants; to India, where it is being considered as a solid reducing agent for iron ore; to Thailand, which has limited fuel resources and some hand-fired central stations; to Japan, where Allied Headquarters have recently prepared a report on lignite; and to Australia, where studies are continuing. In addition to its use as a fuel, Dr. Burr reported that lignite or derived products may be used as "Darko Char," as a water-conditioning chemical, as a staying agent for Vandyke brown, as a blending agent with well-drilling muds, and as a source of coal tar.

Studies are now under way to determine various physical and chemical properties of lignite. Projects include a study of the distribution of mineral matter in lignite, research on the possibilities of finding rare elements such as germanium and uranium in lignite, studies of sulfur content, perfection of new methods of determining moisture content, an investigation of vapor pressure of water within lignite, and studies in wax content and methods of extraction.

Storage of lignite has long been a problem, although recent experiments in connection with the storage of large quantities unearthed during the construction of Garrison Dam have provided encouraging results. The tests were begun five years ago with initial piles of 20,000 tons. Approximately 800,000 tons has been in storage, some as long as four years, with but one fire during the period.

Much work is being done in connection with the drying of lignite. Studies of steam drying have been made by the Bureau of Mines at Denver at pressures up to 400 psig, and it is proposed to carry out experiments with 1500-psig steam. A method of suspension drying similar to Combustion Engineering flash drying has been developed. Also, as has been reported in connection with a plant to be built by the Texas Power & Light Co. for the Aluminum Company of America, a process has been developed to carbonize lignite, obtaining a high-heating-value char and crude coal tar. Research is under way to improve the briquetting of lignite. In connection with synthetic liquid fuels, pilot-plant operation is continuing at Grand Forks, N. Dak., on the gasification of lignite.

Lignite, as a highly valuable and easily recovered material, is expected to become the basis of an expanding mining industry and also for an embryonic chemical industry.

Coal Handling

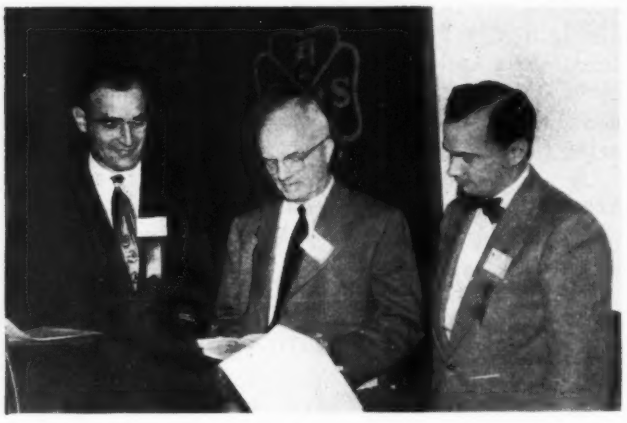
In a paper entitled "Coal Handling Conveyors at Power House and Dock," **Frank W. Lovett** of the Link-Belt Co. made some suggestions on handling lignite. One of the problems encountered is how to overcome conveyor misalignment caused by the freezing of fines and frost particles to belt-conveyor pulleys and idler rolls during the winter months. Recommendations for solving this problem include the following:

1. Replacement of all solid snub and bend pulleys by pulleys of open-slat construction, with bars arranged radially so that their line contact will most effectively cut and loosen the coal and ice frozen on the belt.
2. The use of rotary basine brushes under discharge pulleys as a more effective means of removing loose frozen particles than the usual blade scraper.
3. Using a greater number of self-aligning belt-training idlers in both the carrying and return runs of the longer conveyors.
4. The use of rubber-tread return idlers having spaced disks to decrease contact on the carrying surface of the belt. On long centers it may be sufficient to use a basine brush and three to five of these spaced-disk idlers in back of the discharge pulley. On some belt conveyors where freezing conditions are known to be more severe, it may be advisable to use this type of return idler throughout the full length.

E. E. Bauer of Heyl & Patterson, Inc., in a paper entitled "Coal and Ore Transfer from Rail Car to Lake

Vessel," described the modernization of the equipment of the Rail to Water Transfer Corp. in Chicago. One of the problems was to keep degradation of Southern Illinois and Indiana coals to a minimum during the transfer process. Experience has shown that a telescopic chute with a trimmer gate is most satisfactory to minimize degradation while maintaining rapid loading and directing coal to the corners of the hold.

On other installations of this type, the operator of the equipment was placed in a cab near the mouth of the telescopic chute. In this case it was decided to make the tower movable and therefore overhead weight was reduced to a minimum. It was still necessary for the operator to have visibility of the operation, and accordingly he was equipped with a control box weighing 28 lb. This is worn in a manner analogous to a musician carrying an accordion, leaving the operator free to move about the deck of the vessel as the loading progresses. The control box includes six control buttons with which



Fred T. Agthe addressing Junior Conference as D. J. Greenwald, Jr., and Dean B. Chenoweth look on

the chute can be raised and lowered and pulled inboard or outboard. In addition the operator can completely rotate and open and shut the trimmer gate for the proper flow of coal. This arrangement has proved to be satisfactory for handling both coal and iron ore.

"Storage of Coal" was the topic of a paper by **W. L. Lundy** of Kimberly-Clark Corp. who enumerated certain rules to be followed in storing coal.

1. If economically possible, select a coal that is low in pyrites and has a low phenol extraction number. Uniformly sized coal should be stored wherever possible, and both breakage in handling and segregation of lumps and fines should be avoided.
2. If nut and slack, or screenings, are to be stored, the pile should be compressed by scraping and bulldozing or tamping.
3. The storage pile should be on a well-drained site and away from any external source of heat.
4. Foreign materials should be removed from the storage pile. Care should be taken to avoid storing freshly mined coal in contact with old coal.
5. In some instances it is advisable to keep a weekly record of temperature at various locations in the pile. In case of marked rise of temperature from one week to the next the hot spot should be removed. Space should be left at the storage site to accommodate coal that may have to be moved because of hot spots.

Discussion

Mention was made of the necessity of compacting lignite when it is stored. Average weight of lignite in the mine is about 90 lb per cu ft, which contrasts to a value of about 45 lb per cu ft during transit. For storage it should be compacted to 65 lb per cu ft to avoid firing.

In storing run-of-mine coal out of doors it was recommended that it be sealed with capping material. Estimated cost of storage with capping material, including application, was 27 cents per ton. The discussion also brought out the hazards of storing new and old coal together.

Heat Rate Calculations

"Evaluation of the Effect of Terminal Difference and Pressure Drop on Steam Power Plant Heat Rate" was the title of a paper by **W. F. Allen, Jr.,** of Stone & Webster Engineering Corp. Solution of complete heat balances by conventional methods for determination of the effect on heat rate of changes in terminal difference, pressure drop in extraction piping and cascading versus pumping heater drips requires an almost prohibitive amount of engineering time to explore all realistic possibilities. The accuracy obtainable using curve sheet data to the scales normally furnished when computing heat balances by ordinary methods is open to question when deciding what terminal difference or pressure drop is economical for an individual heater and extraction line or whether it is economically justifiable to substitute a drip pump for a drain cooler. This is because the change in heat rate thus obtained is a small difference between two very large quantities.

Mr. Allen proposed a difference method based on considering primarily the changes in mass flows and enthalpies due to imposed minor variations in cycle conditions, including terminal difference, extraction-line pressure losses and cascading versus pumping heater drips.

In order to illustrate the procedure and the degree of accuracy obtainable with the method, heat-rate changes due to terminal differences and extraction-line pressure drop were presented for a 60,000-kw Preferred Standard turbine-generator unit operating at 850 psig, 900 F with five heaters. The results were compared with those obtained by two short cut methods previously proposed by J. K. Salisbury and Allen Keller.

A suggested set of rules for applying the difference method is as follows:

1. Consider the condenser flow constant.
2. Make a preliminary estimate of the change in extraction flow to the heater or heaters principally affected. Use the value of the enthalpy at the condensate outlet of the heater as the datum.
3. Use the preliminary estimate of changes in extraction steam flow to the heaters principally affected to estimate changes in drip flow.
4. Compute changes in extraction steam flow to each heater, commencing with the lowest heater that is affected.

5. Cease modifying drip flow when desired accuracy is obtained.

6. Use change in total extraction steam flow to compute change in heat rate.

Discussion

There was considerable interest in the fact that the proposed method is applicable to a phase of power plant design that in the past has largely been empirical, namely the sizing of extraction lines. On the other hand, the existence of discrepancies between Mr. Allen's method and those previously proposed by Messers. Salisbury and Keller is something that must ultimately be reconciled.

The economics of reducing terminal differences in heaters was mentioned, and it was pointed out that desuperheating sections in high-pressure heaters in large utility stations have become rather common practice. These pay off in the highest stage and sometimes in the one or two following stages as well. Subcooling sections also offer gains which may have economic justification.

Deaerating Feedwater Heaters

Vincent J. Calise and **R. K. Stenard** of the Graver Water Conditioning Company were the authors of a paper entitled "Trends in Application of Deaerating Heaters for Treatment of Boiler Feedwater." They presented eight case histories, four from industrial power plants and four from central stations, in which they cited considerations in the selection and application of correct designs of a number of types of deaerating heaters. Each industrial case study included an analysis of the following factors:

1. Thoroughfare versus non-thoroughfare arrangement of steam and water flow relative to each other.
2. Internal versus external tubular vent condensers.
3. Tray versus spray deaerating heaters.
4. Materials of construction.
5. Amount of deaerated water storage.

One distinction between operation of deaerating heaters in industrial plants and in central stations is that operating pressures in the latter are generally higher. In addition, central-station heaters usually employ steam extracted directly from one of the bleed stages on the turbine, and their heat cycles are such as to require close control of deaerating-heater-steam operating pressure and temperature. When turbine load falls off rapidly, there may be cases when the drop in extracted steam pressure on the heater results in an operating pressure below atmospheric pressure. Under these conditions non-condensible gases must still be removed from the heater by proper venting.

Automatic ejecting equipment may be employed to create a vacuum and remove non-condensible gases from the heater when extracted steam falls below a fixed point. Another method is to use a pressure reducing valve to supply steam to the heater from one of the higher turbine bleed points or to supply steam directly from a boiler header through a pressure-reducing valve. A third method is to maintain a constant low pressure regardless of load fluctuation, while a fourth is to use turbine condenser vacuum for discharging non-condensible gases.

Feedwater Treatment

D. C. Carmichael of Du Pont de Nemours delivered a paper on "Industrial Plant Boiler Feedwater Treatment." Since makeup for industrial plants may vary from 20 to 100 per cent and pressures for these plants often rival those of public utility stations, careful study of feedwater treatment is required in order to find the most suitable and economical method for conditioning feedwater. Such a treated water should give the following results:

1. Heating and evaporating surfaces of the boiler should be kept clean by reduction of the calcium, magnesium and silica content of the water to low limits.
2. The metal of the boiler must be protected by maintaining a satisfactory pH value and by eliminating free oxygen.
3. Carryover of liquids or solids in steam leaving the boiler must be reduced to a minimum.

With surface supplies of raw water, sedimentation and filtration are generally required. Because of more stringent regulations applying to drinking water, it is advisable to divide the sedimentation-filtration plant for drinking water and for process and boiler-feed purposes.

Among the most common ways for external softening of water for boiler feed are (1) continuous softening using either cold or hot process with lime and soda ash and/or sodium phosphate, (2) continuous softening using hot process followed by hot zeolite softeners and (3) base exchange or zeolite softening.

The author gave examples of the applications of the several softening methods to typical waters available at plants of his company.

Process Steam Turbines

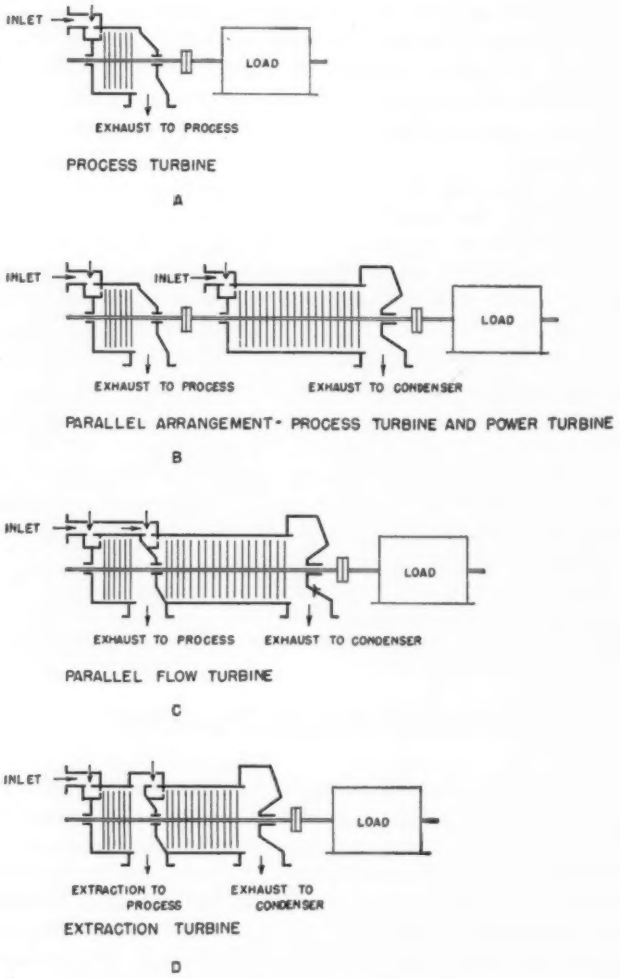
"Progress in Development of Process Steam Turbines for Industry" was the title of a paper by **A. D. Somes** of the General Electric Co. By generating steam at a pressure above the process level and using the expansive energy in a turbine, power can be produced at a very low incremental fuel rate. Where steam must be generated to serve the needs of the process, by-product power can be made by a process turbine at an additional consumption of approximately 4250 Btu per kwhr in the case of a paper mill having a 1200-ton production per day and a power load of about 40,000 kw. This may be compared with 11,500 Btu per kwhr for prime power in an equivalent plant. While there is an increase in plant investment because of the higher pressure and temperature equipment, the increased cost per kilowatt of capacity is generally only a fraction of that for prime generating equipment.

Basically, the process turbine accommodates itself to the steam flows required by the process while extracting as much power as practical. On small turbines a single throttling valve is frequently used for control. However, greater efficiency and increased output are obtained from multiple sectionalized nozzle control valves.

In some plants steam may be available at a given pressure in excess of process needs at that pressure. It may then be used in a process turbine exhausting to a

lower process pressure or to a condenser, or it may be inducted into another turbine in the reverse operation of extraction. Most automatic extraction turbines can be modified to take in a limited amount of steam in this manner.

Process and power-balancing turbines may be effectively combined into a single unit to form an automatic extraction or parallel-flow turbine. In industrial plants, the automatic extraction turbine is the most frequently used type. The advantages of com-



Types of process turbines

bining several elements into a single unit are: (*a*) lower cost, (*b*) less space, (*c*) reduced losses, (*d*) higher average output with widely varying flows, (*e*) coordinated and simplified control, and (*f*) less hazard of outages.

Single automatic extraction turbines were in use as early as 1914, and double-automatic extraction turbines in 1925. The first triple-automatic extraction turbine is expected to be placed in service in 1951. Because of unusual plant conditions it is actually arranged for the induction of steam at the upper point and will normally operate with steam being passed into the machine rather than extracted. The machine has a capacity of 10,000 kw, with inlet steam at 1250 psig, 950 F and exhaust at 2 in. Hg. Steam is also admitted at 400 psig and extracted at 150 and 80 psig.

Discussion

Several questions related to trends in steam pressures for industrial power plants with major process steam requirements. Pressures on the order of 1200 psig are becoming common in paper mills with power loads of 10,000 kw, while 700 to 800 psig is common in slightly smaller plants. Selection of pressures ultimately becomes a matter of the economics of heat balance.

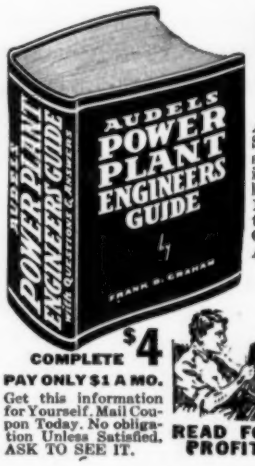
Some interest was shown in the interconnection of automatic extraction and controlled back-pressure machines with utility systems. Many turbines have had incorporated in their design provision to transfer from pressure control to speed control, so that there is flexibility of operation under emergency conditions.

Post-Graduate Training

John Gammell of the Allis Chalmers Mfg. Co. described his organization's program for post-graduate training of engineers. Good training begins with recruiting, and during the first interviews an attempt is made to give the students a good picture of the company and its operations. Upon arrival at the factory the trainees are given physical and psychological examinations. They are also given an induction lecture and a series of talks by various members of the training staff.

On-the-job training is the principal method used in the two-year program. During the first eight or nine months the student trainees work in the shops, mostly on tests and assembly jobs, moving from one job to another about every two months. They then return to the offices, where they spend four to six weeks in several applications departments and two to three months in design departments.

A voluntary method of selection is used enabling choice of training locations which appeal to the student. A number of lecture courses are also given during the training period. After a year, a series of interviews is arranged with six or seven executives. These discussions give a basis of placement, although the real placement is done by the student himself who finds a spot he likes and sells himself into it. Encouragement is given for continued theoretical growth through enrollment in graduate courses conducted at the plant.



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Stress Analyses of Valve Bodies

The desirability of stress analyzing new valve body designs to supplement and modify calculations is explained and the brittle lacquer, bonded electric resistance strain gage, and photoelasticity techniques are described.

WHAT does experimental stress analysis mean to the steel valve designer and how does he employ the results? The answer to this question, which is also of general interest to the valve user, is given by W. L. Hemingway, research metallurgist of Edward Valves, Inc., in the current issue of that company's publication "Valve Values," upon which the following digest is based.

American Standard B16e, 1939, dealing with steel pipe flanges and flanged fittings, states that the minimum metal thicknesses are based on an allowable fiber stress of 7000 psi as determined by a formula for cylindrical sections equal to those in the adjoining pipe. To the metal thickness thus determined, 50 per cent additional thickness is added to compensate for shape.

Since stresses other than those created by pressure are not taken into consideration by the foregoing requirements, they fall short for design purposes. These stresses may be due to shapes deviating from the simple cylinder, to loads imposed during assembly, to valve closing or to certain line conditions. Since stress concentrations due to change of section or "shape factor" are covered only by the general requirement of 50 per cent extra wall thickness throughout the valve, extra metal is often added where not needed, or there may be insufficient metal at certain critical points. Furthermore, there is no printed requirement limiting excessively heavy wall sections that may be responsible for high thermal stresses in high-temperature service. Unnecessarily heavy valves mean bulkier supports and increased costs.

The design of a valve body usually constitutes a problem because of varying shapes, all integrally attached to one another, so that stresses occurring in one section influence stresses in adjacent sections. Thus, the few formulas available for calculating such stresses are most complex. They generally involve empirical values and are not completely accurate. Hence it is far easier to conduct an actual test.

Through employment of experimental stress analyses and their correct interpretation, a greater degree of structural soundness in valve body design is attainable.

As Mr. Hemingway points out, while his company's preliminary valve designs are based on calculations, the first body of a new valve design is stress analyzed to determine what walls or sections must be redesigned or reshaped in order to eliminate excessive stresses and to reduce wall thicknesses that may be heavier in certain

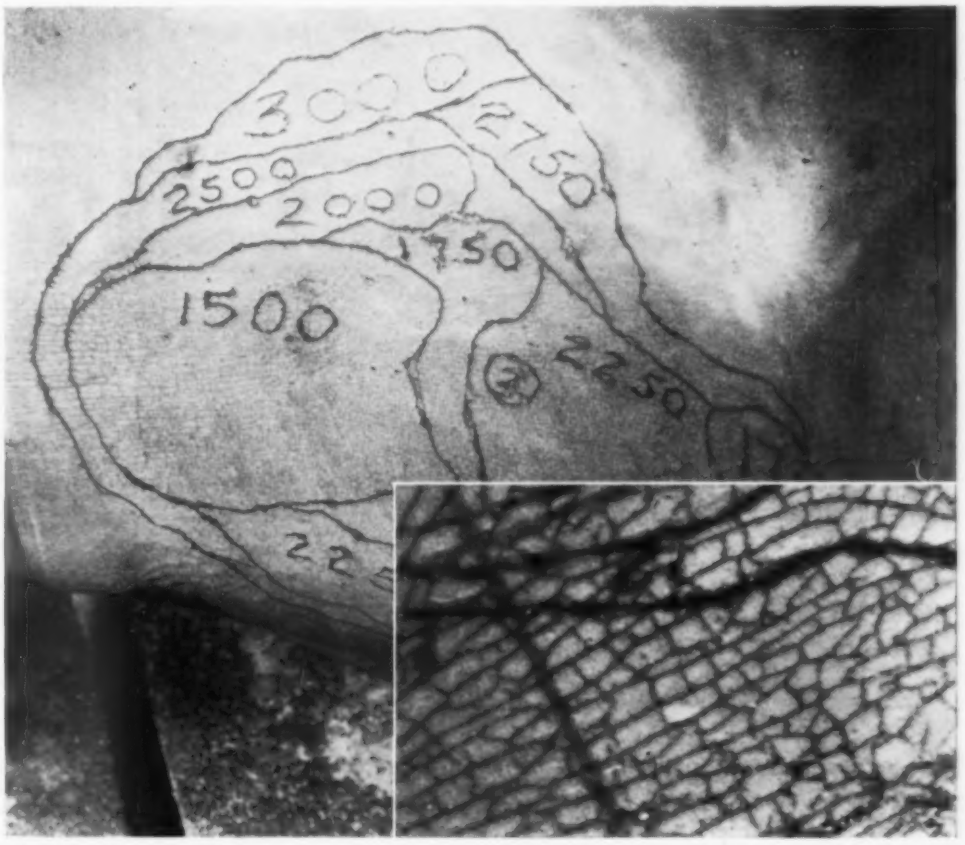


Fig. 1—Large illustration shows progressive failure of brittle lacquer by incremental application of load to valve body. Line, known as an isoentatic, is drawn around each pressure area by connecting the ends of the cracks. Insert shows close-up of cracks.

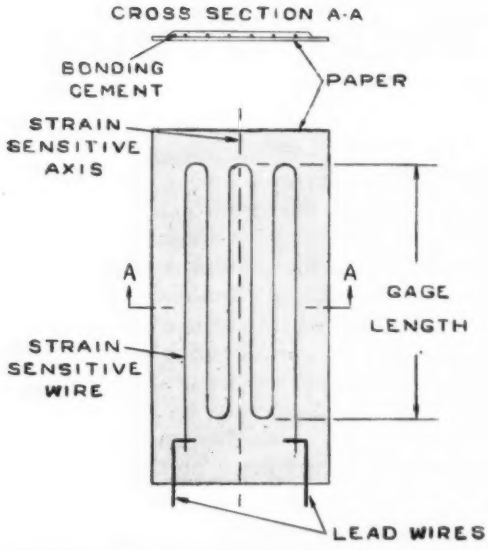


Fig. 2—Diagrammatic representation of typical strain gage.

areas than actually required. Based on the test results and calculations of the initial stress analysis of the experimental model, another valve body is designed and again stress analyzed to determine whether any high stress concentrations remain. Generally, the results verify the revised design, although occasionally additional stress analyses are made to further check calculation. These stress analyses help the design engineers to arrive at the following:

1. Gain optimum distribution of metal.
2. Taper off peak and local stresses.
3. Increase the strength of the valve body.
4. Reduce the weight of the valve body.
5. Obtain greater overall design compactness.
6. Achieve a sound structural design.

To further prove experimental stress analyses results and calculations, newly designed valves are often subjected to a simulated service test.

Three techniques of experimental stress analyses are described. These are brittle lacquer, bonded electric resistance strain gages and photoelasticity, the first two of which are employed most frequently.

Brittle Lacquer Tests

Brittle lacquer presents an overall picture of the stresses on the surface of the valve. It shows areas of stress concentration, type of stress and the direction of the principal stresses. A lacquer coating on a valve will crack when the tension strain on the metal surface is equal to or greater than the sensitivity of the coating. These cracks or lines of failure that appear in the lacquer coating are called isostatics or trajectories of the principal stresses. The isostatics are always tangent or perpendicular to the direction of the maximum principal stresses when strained in tension. Fig. 1 represents such an example which has been dye-etched to increase visibility.

The brittle lacquer is easy to apply, it indicates the tendency for strong sections to pass the load on to weak

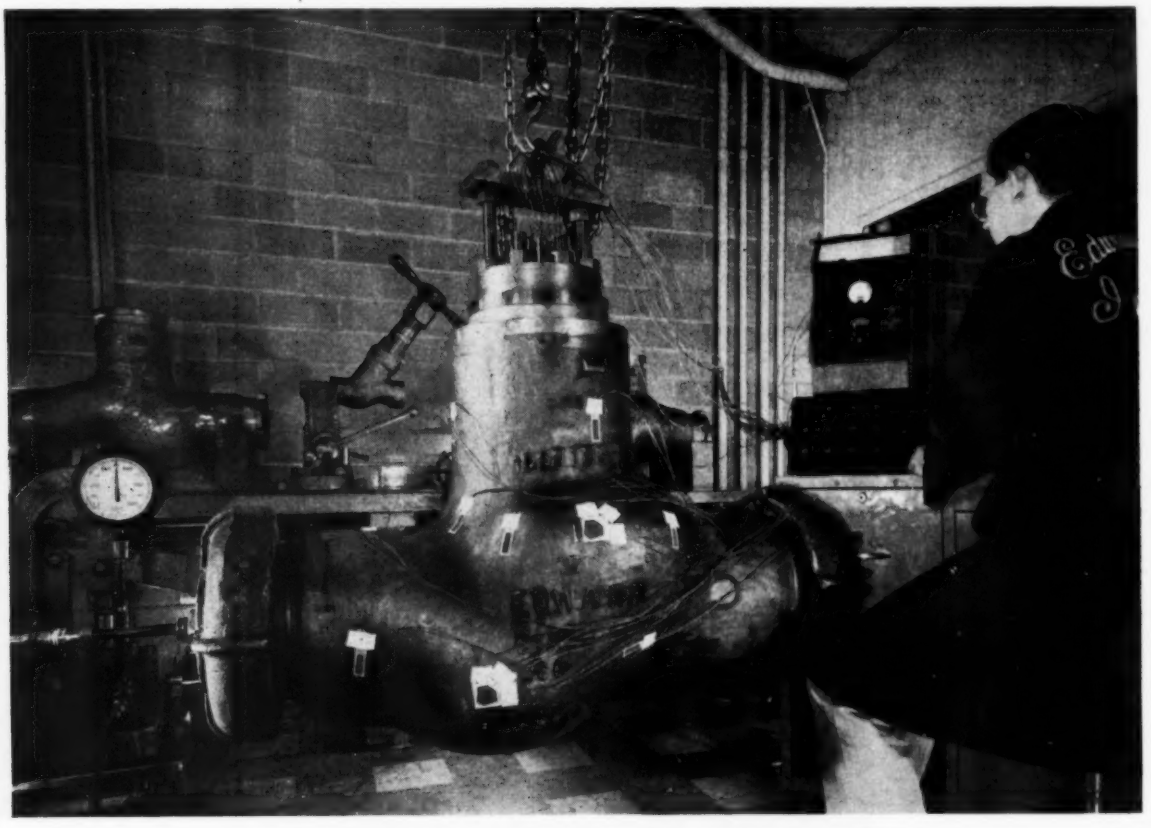


Fig. 3—Strain indicator and bridge balancer on valve under test in Edward laboratory and arranged for simultaneous study of stresses on both internal and external surfaces. Wires on top lead to internal strain gages.

regions, and it can aid in determining where strain gages should be mounted.

Bonded Electric Resistance Strain Gages

The principle of the bonded resistance wire gage is based upon the change in electrical resistance of a fine wire as it changes in length, the sensitivity depending upon the ratio of change in resistance to the change in length.

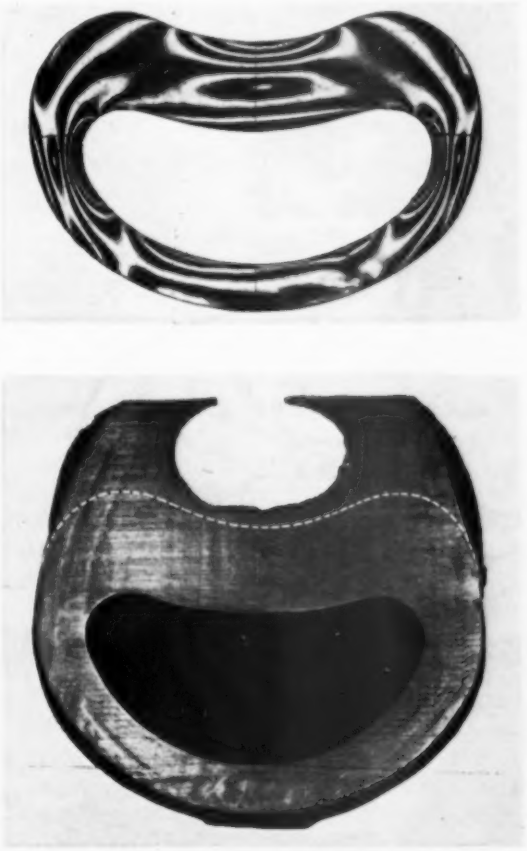


Fig. 4—Top view shows photoelastic model of valve section used for design calculations. Points of convergent fringes indicate greatest stress. Lower view shows resulting shape of the sectioned test valve.

The strain gage is bonded to the surface of the valve body with an elastic cement, generally nitrocellulose; but if the valve is to be subjected to high temperature, phenol-resin cement is used. Since the diameter of the strain-sensitive wire is so small, usually only 0.001 in. and the mass of cement relatively much greater, the wire must deform as directed by the cement. Construction of a typical gage of this type is indicated in Fig. 2. A Wheatstone bridge is generally employed for measuring the changes in resistance with accuracy, and there are many types of accessory instruments that can be used to determine weights, stresses, pressures, moments, etc.

Photoelasticity

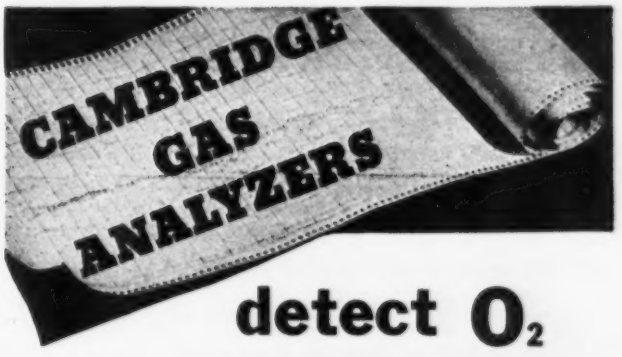
Photoelasticity is based on the fact that when certain transparent materials are stressed their optical properties undergo changes. Essentially these changes take place because the material becomes doubly refractive. Polarized light passed through the material vibrates in two planes perpendicular to each other. The velocity of light passing through the model is a function of the intensity of the principal stresses. Thus, the interference bands which are then produced can be interpreted as stresses.

Photoelasticity may involve one of two types: two-dimensional or three-dimensional.

For the two-dimensional type, a transparent model of a section of the test valve, $^1/_4$ to $^1/_2$ in. thick is cut and finished to scale. It is then stressed in a polariscope and the patterns immediately examined or photographed for examination later. The transparent models are loaded similar to what the prototype would carry, and the stress conditions of the model usually coincide with those of the actual valve. When using monochromatic light, dramatic light and dark bands appear which are known as fringes; see Fig. 4.

A drawback of the two-dimensional method is that it does not always reflect accurately the conditions of three-dimensional reality. However, three-dimensional photoelasticity has not yet been fully developed, and there is usually difficulty in making a three-dimensional model.

Photoelasticity is a valuable adjunct for the development engineer using experimental stress analyses, as it reveals stress distribution not only at the surface but throughout a section indicating stresses in otherwise inaccessible locations.



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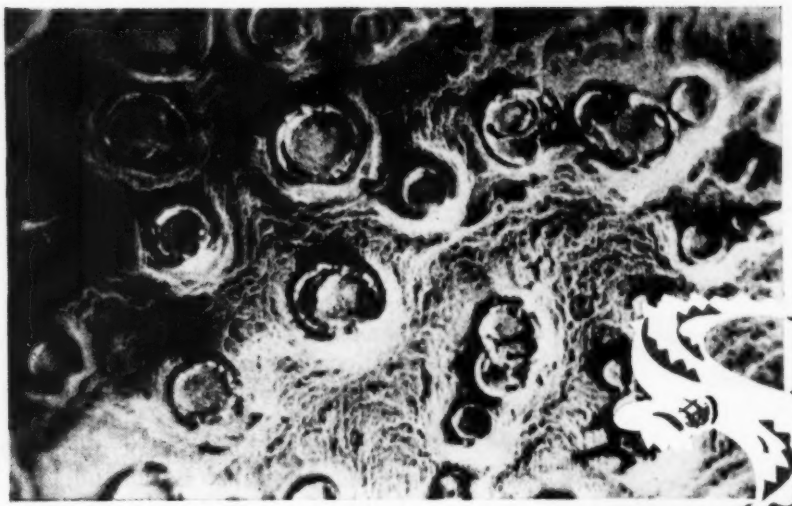

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Boiler Operation with Lignite

Following is a digest of a paper by J. W. Hoffman, of Northern States Power Company, and John M. Drabelle, of Iowa Electric Light & Power Company, presented at the recent A.S.M.E. Fall Meeting in Minneapolis. It reviews the history of burning lignite from Canada and our North Central states with both stokers and in pulverized form. Included are certain design data and the experience of some users.

LIGNITE is basically a high inherent moisture coal, containing 30 to 40 per cent moisture, and relatively low in heating value. Because of these factors it is uneconomical, at present freight rates and competitive bituminous coal prices, to ship it greater distances than 200, or 400 miles at the most; hence it is considered a local area fuel. Vast deposits exist in North Dakota and in the Canadian provinces of Saskatchewan and Alberta. It is mined largely by the strip process at relatively low mining cost which tends to offset the moisture and freight situations.

Historical Development

The real development of fuel-burning equipment for use of lignite in utility and industrial applications began around 1925 in the United States and 1915 in Canada. The early stokers were known as the sprinkler type, the forerunner of the spreader. These were installed not only to reduce labor but also to permit the use of lignite screenings which the mining companies were accumulating due to the normal domestic demand for lump size. Generally, rather poor results were obtained. Basic thinking was later directed toward more efficient combustion through evaporating the inherent moisture, ignition of the volatile and burning of the remaining carbon. To this end it was believed that the temperature should be raised to preheat the fuel. This seemed to point to use of the chain-grate stoker with long refractory arches, both front and rear. A number of such stokers were installed with various arch designs. While some were efficient, they had a rather low rate of response to load demands and often involved high maintenance costs, due largely to lack of knowledge at the time of the peculiarities of lignite which later developed as larger installations began to use this fuel.

Pulverizing was attempted at the University of North Dakota, but was soon rejected because of improper and inadequate drying which resulted in high cost of pulverization due to the rather fibrous nature of lignite and particularly ignition difficulties in starting up, control and ignition at low ratings.

A few attempts were made to convert existing underfeed stoker installations from eastern coals to lignite, but they were generally unsuccessful due to lignite being non-caking and to the fact that this type of stoker tended to crush the lignite to a powder and make burning extremely difficult. However, one plant used a mixture of half eastern coal and half lignite with fair success.

By 1930 eastern coals were still in general use in the area but as larger units made their appearance, the active development of spreader stokers to handle lignite began. With spreader firing, however, furnace temperatures were several hundred degrees higher than with chain-grate stokers, and this increased slagging and clinkering difficulties. The burning in suspension had produced a condition not previously anticipated and led to a trend in the late 1930's toward the elimination of arches, the use of water walls, preheated air and an increase in furnace height and volume.

With the spreader stoker lignite is introduced into the highly heated furnace zone where there is a flash explosion of the fuel due to its high inherent moisture content. This results in an instantaneous liberation of moisture and disintegration of a portion of the fuel into small particles which mix intimately with the air, water vapor and volatile. This reduces the remaining solid particles of lignite to be burned on the grate by about 50 per cent. The portion burned in suspension is, of course, a function of size.

The long flame and the large quantity of low fusion temperature fly ash resulted in rapid plugging of the boiler passes on the early installations, to cope with which furnace heights were increased to afford more complete burning and reduce the temperature of the fly ash. Both slag screens and water-wall surface were necessary to reduce the furnace temperature. Evaporation of the moisture not released before the fuel reaches the grate tends to reduce the temperature at the grate. Therefore, although dealing with a low-ash-fusion fuel, preheated air can be utilized to advantage to accelerate combustion and reduce the length of flame without abnormal clinkering problems.

Due to the high inherent moisture content of lignite, there is released in the furnace a large amount of highly superheated steam along with the combustion gases. This results in high mass flow of gas through the superheater, boiler passes, air preheater and economizer. Thus predicted steam temperatures may be overshot unless a smaller amount of superheater surface is used.

Storage of Lignite

Lignite fires readily in storage, particularly during the summer months. Hence, it is usual to maintain an emergency storage pile of eastern coal at the plant site and to store lignite only in such quantities as may be necessary to absorb normal irregularities in transit shipments. The best practice is to build up the storage pile in one-foot thick layers not exceeding a total of six to eight feet in height, compacting each layer with a bulldozer, sheep-foot packer or roller. There are now a number of lignite storage piles in excess of 5000 tons each that have been in existence for several years.

Questionnaires sent to the larger utility and industrial users of lignite in North Dakota, Wyoming, Minnesota,

Alberta and Saskatchewan brought replies from five United States companies and three Canadian companies. The former reported fourteen boiler installations of which thirteen were spreader-stoker-fired (with continuous discharge grates) and one pulverized-fuel-fired. The latter reported three installations, one stoker-fired and two employing pulverized lignite. All these installations were made within the last five years and ranged in capacity from 60,000 to 160,000 lb of steam per hour. The furnace heat releases ranged from 19,600 to 24,500 Btu per cu ft and the air preheat temperature from 300 to 400 deg F. While the replies reflected relatively conservative furnace design, there was considerable variation in the Btu per square foot of projected water-wall surface (152,000 to 237,000).

The relatively large quantity of fly ash and the low combustible content of the ash does not make reinjection very attractive. Of the fourteen stoker-fired installations reported, eleven were equipped with dust collectors. Of these, two returned the dust from the boiler pass, air preheater and collectors to the furnace and three were returning only that from the boiler pass and air preheater. The others returned the entire catch to the ash-removal system.

All but three of the fourteen stoker-fired installations employ overfire air. When burning lignite, overfire air does not appear essential from the standpoint of avoiding smoke, but it is most desirable in promoting turbulence in the furnace. Current practice is to operate with about 30 per cent excess air and operation at 14.5 to 15 per cent is not unusual. Boiler efficiencies compare favorably with those obtained when firing other fuels, after adjusting for the higher flue gas loss due to the evaporation of moisture.

The frequency of boiler outages for cleaning is not abnormal. Conventional soot blowers are used in the boiler passes and occasionally furnace wall blowers are installed. The slag formation in the furnace and on the slag screens is for the most part of a spongy nature and will drop off during light load periods, or can be removed by lancing. Lignite from some fields will deposit a hard white scale, principally sodium sulfate which is readily soluble in water. This is likely to be found in the first pass, through the entire boiler, to and including the outlet damper. Many of the plants that burn this type of lignite wash the gas side of the heating surfaces with water during boiler outages. However, the boiler should be hand-lanced with compressed air before washing.

Data received from the three installations burning pulverized lignite showed capacities from 60,000 to 100,000 lb of steam per hour, furnace heat releases from 18,800 to 20,500 Btu per cu ft per hr and 69,000 to 94,000 Btu per sq ft of projected water-wall surface.

The Hardgrove grindability index of lignite ranges from 45 to 50, and the power consumption and mill capacity varies with the moisture content. Current practice indicates approximately 12 per cent of the total moisture is removed in pulverization which removes all the surface moisture and a part of the inherent moisture. To produce these conditions the temperature of the air to the mills is in the range from 600 to 700 F, and the air-fuel mixture from the mills is maintained at 140 to 200 F. The power consumption of the mills is in the vicinity of 20 kwhr per ton. However, large mill capacities are necessary due to the low heating value of the fuel.

Reported Tests

Tests were reported on a Babcock & Wilcox-Goldie-McCulloch boiler burning pulverized lignite at the plant of Polymer Corp. Ltd. This unit was designed for 275,000 lb per hr at 430 psi, 650 F and 220 F feedwater temperature. A Ljungstrom air preheater supplies air to the burners and mills at 510 F.

The proximate analysis of the lignite showed 39 per cent total moisture, 26.1 per cent volatile, 29 per cent fixed carbon, 0.6 per cent sulfur and 5.9 per cent ash. The heating value, as received, was 6800 Btu per lb and the initial deformation of the ash was 2170 F in a reducing atmosphere, or 2190 F in an oxidizing atmosphere.

The performance was reported as satisfactory over a load range from 60,000 to 200,000 lb of steam per hour, the latter limit being dictated by pulverizer capacity. Excess air was maintained at 22 per cent at the boiler outlet with a clear stack at all times, and primary air temperature to the pulverizers and secondary air temperature to the burners was 500 F. The coal-air temperature was 125 F with a coal temperature to the pulverizers of 350 F. Dust from the precipitator contained 1.4 per cent carbon.

A second test of seven days was reported. This was with ten cars of North Dakota lignite burned in a cyclone furnace at the Calumet Station of the Commonwealth Edison Company, Chicago. The boiler in this case has a capacity of 180,000 lb per hr at 350 psi, 650 F and 220 F feedwater temperature, with preheated air at 457 F. The lignite, as received, analyzed 38 per cent moisture, 29.1 per cent volatile, 27 per cent fixed carbon, 5.9 per cent ash, 0.4 per cent sulfur, and a heating value of 6830 Btu per lb. The initial deformation of the ash ranged from 2270 to 2340 F.

The high moisture content caused some ignition difficulties in the early part of the tests, but these were overcome by burning natural gas in the primary air line to the crusher, raising the temperature to 650 F. Outputs up to 170,000 lb of steam per hour were carried with satisfactory operating conditions and without smoke. The slag behavior was similar to that of the Illinois Kincaid coal normally burned at this plant.

A statement by Westinghouse Electric Corp. included the following recommendations for spreader-stoker firing of lignite:

1. Furnace heat release not to exceed 30,000 Btu per cu ft per hr.
2. Water cooling on all four walls.
3. Sustained combustion rate limited to about 600,000 Btu per sq ft of grate per hour in order to minimize fly-ash carryover.
4. Because of the lower specific weight of lignite, where grates exceed 16 ft, the fuel distributors should be located at a higher level than for bituminous coal.
5. Because of the high volatile content and the greater ability of lignite to burn in suspension, a higher ratio of secondary to primary air may be employed, resulting in reduced carryover. Thus provision for oversize secondary air fans is advisable, at least to the extent of 25 per cent of the theoretical air.
6. Because of the ability to burn more of the total combustible content above the grate, fire-bed temperatures are lower for equivalent conditions. Therefore, primary air temperatures may be increased to somewhat higher values, of the order of 375 to 400 F, without encountering difficulty from fusion of ash on the grate.

Facts and Figures

It takes 200 tons of coal to produce an army tank.

•

The nation's recoverable lignite reserves are estimated at 356 billion tons.

•

Packaged or bagged coal is now sold through vending machines.

•

The first public lighting system was put in operation in Appleton, Wis., in 1881, just prior to the Pearl Street Station in New York.

•

Last year more than 3,600,000 tons of small-sized anthracite was consumed in power generation, of which utilities accounted for 44 per cent.

•

Scrap is still in very short supply and, according to Defense Mobilizer Charles E. Wilson, 3 million tons are needed monthly to meet scheduled steel production.

•

In all parts of the United States the water level beneath the earth's surface is dropping and in some parts of the Southwest this is as much as five feet per year.

•

The largest gas-turbine plant in operation to date is rated at 40,000 kw. This plant, at Beznau, Switzerland, contains two units, one of 27,000 kw and the other of 13,000 kw.

•

According to Bituminous Coal Institute, more than six thousand independent coal producing companies make up the American coal industry.

•

The British Electricity Authority estimates a national deficit in power supply during the coming winter of from 1,800,000 to 3,100,000 kw, depending on conditions at that time.

•

The annual per capita consumption of electricity in France is reported as 750 kwhr compared with around 900 in Britain and over 2000 in the United States.

•

Natural steam power plants in and around Larderello, Italy, now have a total installed electric generating capacity of around 250,000 kw, the largest units being rated at 35,000 kw.

•

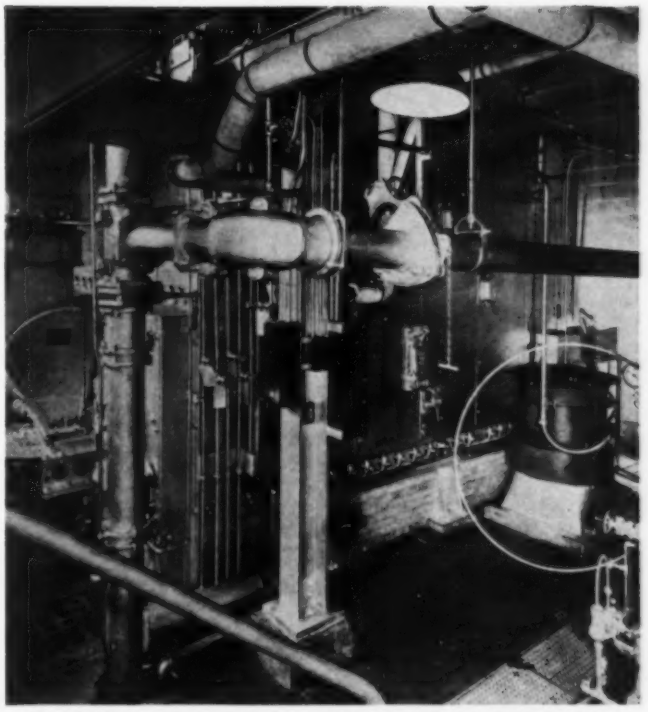
The first successful oil pipe line was laid in 1865 and was four miles long. There are now close to 160,000 miles of such lines in the United States.

•

In these days of concentration of power generation in very large units, it is surprising to note that Henry Kaiser's new aluminum plant in Louisiana will contain eighty 1820-hp gas engines of the radial type, each having eleven cylinders.

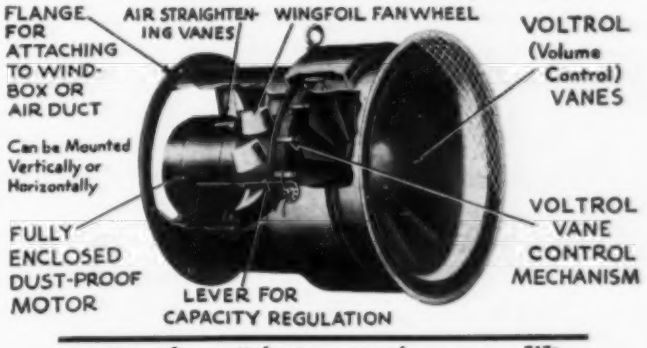
•

During the current year, under our technical assistance program, some thirty teams are arriving monthly to study American methods. These teams will total about 2500 persons for 1951.



COMPACTNESS, EASE OF REGULATION, LOW MAINTENANCE— —IN THE WING AXIAL FLOW BLOWER

WING AXIAL FLOW BLOWERS are used on many of the country's leading makes of boilers as standard equipment. The reason lies in the


FLANGE FOR ATTACHING TO WIND-BOX OR AIR DUCT
AIR STRAIGHTENING VANES
WINGFOIL FAN WHEEL
VOLTROL (Volume Control) VANES
Can be Mounted Vertically or Horizontally
VOLTROL VANE CONTROL MECHANISM
FULLY ENCLOSED DUST-PROOF MOTOR
LEVER FOR CAPACITY REGULATION

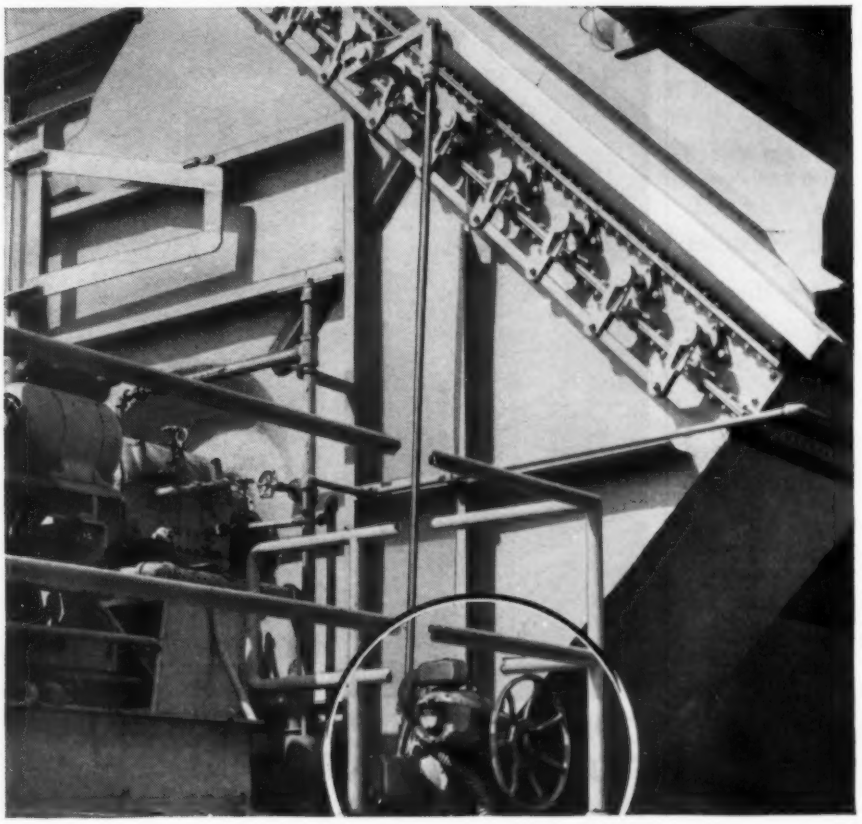
consistently satisfactory performance Wing Blowers have been delivering for over half-a-century—plus many superior features of Wing design, such as the volume control (Voltrol) vanes, permitting capacity regulation down to 10% of maximum. Write for complete details and latest bulletin.

L. J. Wing Mfg. Co. 54 Vreeland Mills Road Linden, New Jersey

Offices in Principal Cities

Wing

AXIAL FLOW BLOWERS



In a semi-outdoor station, Metermax drive unit (in circle) connected to damper, needs no protection against weather—never freezes or clogs.

Electric Muscles for Better Combustion Control

Take a close look at the parts of a combustion control system that do the actual moving of dampers, vanes and other controlled elements. They're mighty important to the overall performance of the control. In the Metermax system, you'll find all these jobs done by electric drive mechanisms, selected for these outstanding features:

Dependable Power Source: Operate from plant power lines, independent of compressed air supply.

Self-Locking: double worm and gear drive can't be backdriven by unbalanced dampers; no locking devices needed.

Self-Releasing: no unlocking or resetting by operator when resuming manual control after shutdown.

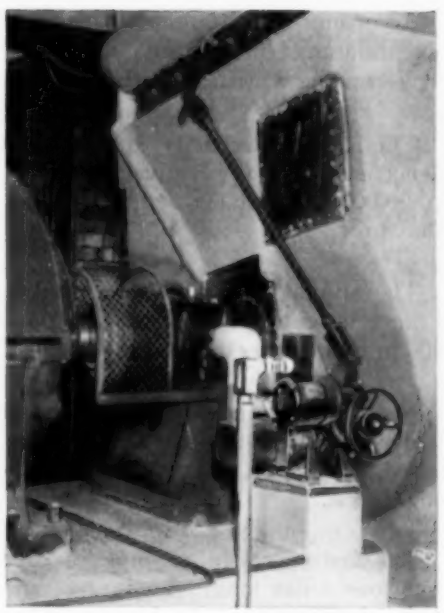
Simple Remote Control: instantaneous transfer from automatic to remote manual operation; no reset position.

Easy Manual Operation: handwheels built into each unit give ample mechanical advantage for moving heavy loads.

True Position Indication: electric indicator on panel responds only to movement of drive shaft; no errors due to friction or sticking of dampers.

Outdoor Service: no clogging or freezing troubles; no steam jacketing or weather shelter ever necessary.

Our new Folder NU9-463(1) gives full details about Metermax electric drive units. For a copy, write to Leeds & Northrup Company, 4972 Stenton Avenue, Philadelphia 44, Pa.



Drive units have built-in mounting feet; are readily bolted to steel or concrete base. Crank and connecting link are supplied with each unit.

LEEDS NORTHRUP

Journal Ad NU9-01-463(4)

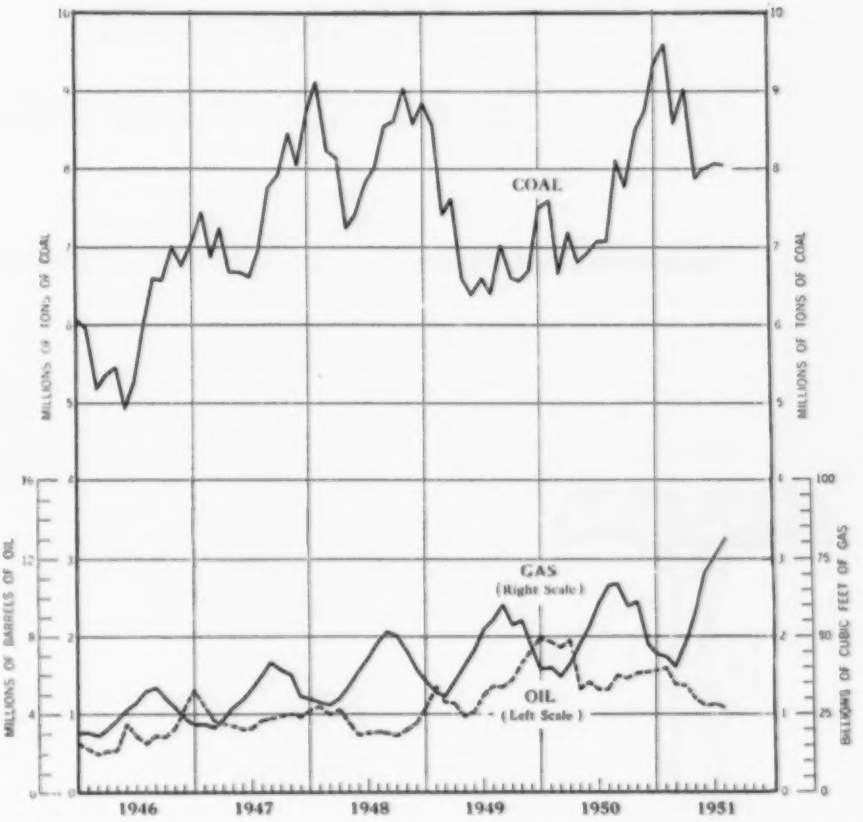
Electric Output and Fuel Consumption Gaining

REPORTING for the month of July 1951, the Federal Power Commission gives the production of electric energy as in excess of thirty billion killowatt-hours, representing an increase of 13.5 per cent over July 1950. Water power accounted for 27.2 per cent of the total and fuel-burning plants 72.8 per cent. This was a decrease of 0.9 per cent of the total for hydro during the year which is attributable principally to decreased rainfall and river flow in the northwest region of the country.

For the twelve months ending July 31, 1951, the output was 307,591,336,000 kwhr, which was the highest total attained during any like period to date.

Industrial Plant Output

Electric power plants of industrial concerns, based on reports from 800 generating plants accounting for 85 per cent of the total production and extended to represent 100 per cent coverage, produced slightly over five billion killowatt-hours in July, which was an increase of 4 per cent over the figure for July 1950. Thus, the combined utility and industrial power plant output totaled 35,434,659,000 kwhr for last July, or 12.1 per cent over the corresponding month of 1950. For the twelve-month period the combined output was close to 417 billion kilowatt-hours, a gain of 14.6 per cent.



August reports to the Commission indicated an installed utility capacity of 72,693,000 kw, which was an increase of 6½ million kilowatts during the year. Utility and industrial plant capacity together totaled 86,681,913 kw.

Gas and Coal Up, Oil Down

The reports show a significant swing from oil to coal by utility plants, although the use of natural gas showed a substantial gain. In other words, coal consumption for the month of July 1951 was up 13.7 per cent over July 1950 and exceeded eight million tons; whereas the fuel oil used was down 18.1 per cent. The natural gas consumed reached a monthly high of 82,322,144,000 cu ft, a gain of 23.4 per cent over that of July 1950.

The indicated average utility coal rate for July 1951 was 1.15 lb per kwhr, compared with 1.17 lb a year earlier.

Coal Stocks

Coal stocks held by electric utilities on August 1 were the highest on record, amounting to over 36,600,000 tons. This figure was 46.3 per cent greater than that of a year earlier. In terms of days' supply, based on the July rate of consumption, there was sufficient coal on hand to last 141 days. This, of course, represents an average for the whole country and does not take into account the winter months when loads are heaviest. Fuel oil stocks were sufficient for 84 days.

STORE COAL FASTER, EASIER

WITH A "ONE MAN"

SAUERMAN

POWER DRAG SCRAPER

The pictures show a Sauerman scraper system that uses a monorail for shifting the scraper around a storage area of irregular shape in the heart of a large city. A maximum reserve of 16,000 tons of coal is maintained on limited space by the scraper which stores and reclaims up to 100 tons an hour.

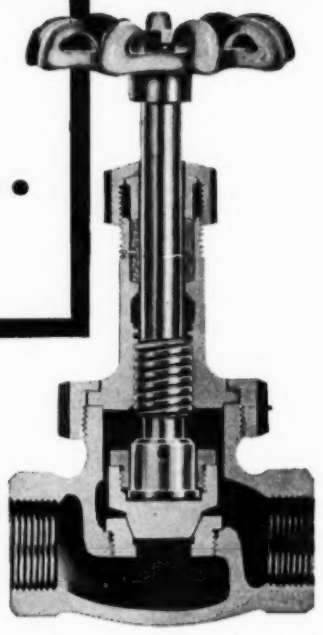
Whether the tonnage of coal to be stored and reclaimed is large or small, the entire job can be done easily by one man with the correct size of Sauerman Power Drag Scraper. Other reasons why Sauerman equipment is preferred at so many power plants are its reasonable first cost, low maintenance cost, ability to operate continuously in all kinds of weather, and the fact that it builds a compact pile which avoids spontaneous combustion.

Send today for the FREE Sauerman Coal Storage Catalog.

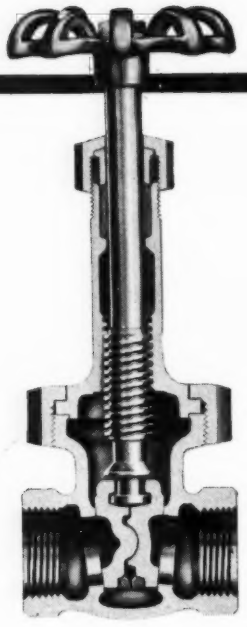
SAUERMAN BROS., Inc.

550 SO. CLINTON ST. CHICAGO 7, ILLINOIS

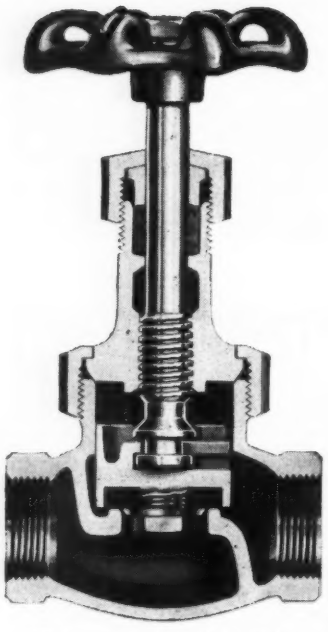
Walworth bronze valves...



Walworth No. 225P Globe Valve
500 Brinell Seat and Disc



Walworth
No. 29 Gate Valve



Walworth No. 95 Globe Valve
Re-New-Disc

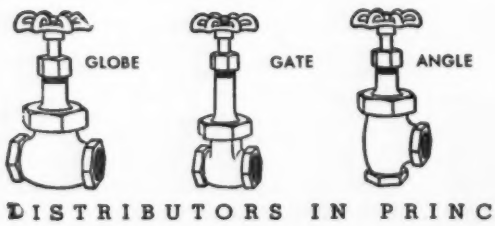
built to give dependable trouble-free service on all recommended jobs

Walworth No. 95 Bronze Globe Valves (Angle Type: No. 96) are recommended for service where throttling is not required. They are rated at 150 psi working steam pressure, 500F; 300 psi cold water, oil or gas. The improved renewable disc and lock-on, slip-off disc holder — an original Walworth development—saves time and trouble. This valve can be repacked under pressure when fully opened. All parts are designed to give maximum service and strength.

Walworth No. 29 Bronze Gate Valves are rated at 200 psi working steam pressure, 550F; 400 psi cold water, oil and gas. These valves have rising stems and integral seats. Sizes 2-inch and smaller have union bonnets; sizes 2½ and 3-inch have bolted bonnets. Valves up to and including ¾-inch have solid wedge discs; 1-inch and larger have split wedge discs. These valves can be repacked under pressure when fully opened.

Walworth No. 225P Bronze Globe Valves (Angle Type: No. 227P) are rated at 350 psi working steam pressure, 550F; and 1000 psi non-shock service on cold water, oil and gas. The stainless steel, plug type seat and disc — heat treated to 500 Brinell — can be closed on sand, slag, scale and similar floatage, without injury to the seating surfaces. They are the longest wearing, TOUGHEST bronze valves you can buy.

For full information about Walworth Quality Bronze Valves, see your Walworth distributor, or write:



WALWORTH
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60 EAST 42nd STREET NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Marking Stacks to Avoid Hazards from Airplanes

A digest of some of the rules prescribed by the Civil Aeronautics Administration, particularly painting and lighting of stacks to provide daytime and night markings, respectively.

THE concurrent increases in air travel, number of airports and new power stations, some for various compelling reasons located in the lines of landing approach, have in many cases set up potential hazards offered by tall stacks and transmission towers. This made it necessary for the Civil Aeronautics Administration to promulgate regulations (first in 1943 and revised in 1951) requiring the submission of certain information prior to the start of construction or alteration of structures falling within the prescribed limits as to heights and distances from air fields.

The limits within which construction requires the submission of certain information have been set with regard to the maximum protection for airmen. These apply to any structure along or within 20 miles of a civil airway, the top or any part of which is greater than 150 ft above ground; or any structure within 15,000 ft of the nearest boundary of a landing area, the top or any part of which is 5 ft above ground level for each 500 ft or fraction thereof of the distance from that boundary.

Standards can be given only general application as regards heights, for in some instances the construction may be so located in reference to other structures or the contour of the ground, such that modifications are permissible. Similarly, the structure may be so removed from the general flow of air traffic that obstruction marking would serve no useful purpose. Each particular problem is a matter for recommendation by especially trained personnel of the CAA which avows its desire to assist those contemplating construction that may present a potential hazard, in order to minimize the possibility of damage from collision by aircraft. Each regional office has special advisory personnel to conduct specific investigations, this service being available upon request.

Obviously, insofar as stack heights are concerned, avoidance of such hazards often imposes limitations that are incompatible with wide dispersion of the products of combustion and makes necessary a compromise solution, such as has been necessary in connection with several recent stations.

Where existing structures are involved, the safety effort calls for marking them conspicuously so that pilots may stay clear of them; and in the case of proposed structures, careful study is required in the planning stage in order that the hazards may be avoided and prompt notification be given to pilots before such structures are erected.

Obstruction Markings

Specifications for such markings, covering painting for daylight warning and lighting for night, are contained in a text revised earlier this year[1] from which the following excerpts are taken:

DAY MARKING—Towers, poles, smokestacks and similar structures that present a hazard for daytime operations in air commerce should be painted throughout their height with alternate bands of aviation surface orange and white, terminating with orange bands at both top and bottom. The width of the orange bands should be approximately one-seventh the height of the structure and the white bands approximately one-half the width of the orange bands; provided the orange bands shall

[1] "Obstruction Marking," 1951, issued by the Civil Aeronautics Administration and obtainable for 20 cents from the Superintendent of Documents, Washington 25, D. C.

RODA — High grade gas, by-product, steam and household stoker coal from Wise County, Virginia, on the Interstate Railroad.

KENDRON — High grade gas, by-product, steam and domestic coal from Wise County, Va., on the Interstate Railroad.

STONEGA — High grade, high volatile steam and by-product coal from Wise County, Va., on the Interstate Railroad.

GLENBROOK — The Premium Kentucky High Splint unmatched for domestic use. Produced in Harlan County, Kentucky, on the L. & N. Railroad.

COKE — Roda and Stonega from Wise County, Va.

CRITERION COAL — High grade gas, by-product, steam and domestic coal—Pittsburgh seam from Irwin Basin, Westmoreland County, Pennsylvania, on the Penna. Railroad.

HAMPTON COAL — High volatile domestic, steam and by-product coal from Boone and Logan Counties, W. Va., on the Chesapeake & Ohio Ry.

CROZER — Genuine Pocahontas from McDowell County, W. Va., on the Norfolk & Western Railway.

LYNCO — High fusion coking coal for by-product, industrial stoker and pulverizer use from Wyoming Co., W. Va., on the Virginian Ry.

GENERAL — REG. U.S. PAT. OFF.

ANTHRACITE
Hazle Brook—*Premium Lehigh*
Raven Run—*Premium Mahanoy*

Capable engineering personnel and the experience gained through long and varied marketing activity assure proper application of one of the above brands and effective servicing of any fuel requirement.

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BLUEFIELD, W. VA. BUFFALO CHARLOTTE, N. C. CINCINNATI
NEW YORK NORFOLK PITTSBURGH

Spotlighting

ACCURACY in the RICHARDSON coal scale

Another reason why thousands of power installations keep an accurate check on boiler efficiency with Richardson Automatic Coal Scales.

The key to Richardson Scale's reputation for consistent accuracy lies in its Weigh Beam System—the heart of every Richardson Scale. Great strength where strength is needed, sound basic design, and precision construction enable this system to maintain an accuracy of 1/4 of 1%. The unit is built of heavy, welded members, free from any tendency to warp or twist with Weigh Beam mounted on hardened steel knife edges, bearing in V-notched, self-aligning, hardened steel blocks. The system is mounted in a separate, dirt-excluding housing to reduce wear and insure long life.

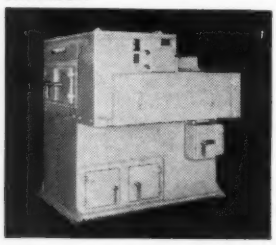
Some other important features that make Richardson Scales the standard of comparison throughout industry are:

QUICK-RELEASE BY-PASS MECHANISM for emergency re-routing of coal direct to stoker or pulverizer.

HINGED LEVELING PLATE to establish a uniform "breakaway" of coal each time the feeder belt is stopped, and to allow passage of occasional large lumps without damage to belt.

DIRECT-CONNECTED DISCHARGE COUNTER to register automatically and unerringly the number of discharges.

ALL ELECTRIC EQUIPMENT mounted outside of corrosive atmosphere of coal chamber.



3 BULLETINS AVAILABLE

Send For Them Today For Complete Information On: EE-39, for dust-tight average service—200-300 lbs. per discharge—**Bulletin No. 0150.**

Model K-39, for pressure-tight (up to 60" of water), large-capacity service—400-500 lbs. per discharge—**Bulletin No. 0250.**

Monorate, non-segregating coal distributor—**Bulletin No. 1349.**

Richardson

MATERIALS HANDLING BY WEIGHT SINCE 1902

8104

RICHARDSON SCALE COMPANY
Clifton, New Jersey
Atlanta • Boston
Buffalo • Chicago • Cincinnati
Detroit • Houston • Minneapolis
New York • Omaha • Philadelphia
Pittsburgh • San Francisco • Wichita
Montreal • Toronto

not be more than 40 ft nor less than $1^1/_2$ ft in width. It is recommended further that where such structures are located within two miles of a landing area, the width of the orange bands not exceed 20 ft. The bottom band of orange and of white may be omitted on structures situated more than three miles from a landing area, or when the lower portion is shielded by surrounding structures or terrain.

NIGHT MARKING—Smokestacks and similar structures which present a hazard to air commerce should be lighted nightly from sunset to sunrise. Those which do not exceed an overall height of 150 ft above ground, or water if so situated, may be floodlighted by fixed projectors installed at three or more points around the base of the possible obstruction.

When the stack or similar structure exceeds 150 ft but is not more than 450 ft in overall height above the ground, there should be installed at a near top level at least three duplex obstruction lights, each consisting of two 100-watt lamps enclosed in aviation red fresnel or prismatic globes (heat-resisting preferred). These must be visible from a vertical angle and should be placed at regular intervals on the horizontal plane in a manner to insure visibility of at least two lights from aircraft at any angle of approach.

On levels at approximately two-thirds and one-third of the overall height, at least three 100-watt lamps, or equal, enclosed in aviation red fresnel or prismatic globes, should be placed at regular intervals on the horizontal plane.

For overall heights between 450 ft and 600 ft, three or more 300 mm electric code beacons, each having two 500-watt lamps and aviation red filters, should be placed at or near the top level and three or more 100-watt lamps (enclosed in aviation red fresnel or prismatic globes) at the one-third, one-half and two-thirds levels of the stack or similar structure.

In all cases the lamps should burn simultaneously.

The operation of permanent obstruction lighting installed on stacks or structures of a height greater than 150 ft above ground, or water, and situated in areas of poor visibility, should be controlled by a light-sensitive control device so adjusted that the lights will be turned on at a north sky light intensity level of 35 foot-candles and turned off at a north sky light intensity of 58 foot-candles.

Where obstruction lighting is not readily accessible for periodic inspections, an electric signaling device, either aural or visual, for indicating lamp failure should be installed.

The 300-mm electric code beacons should be equipped with a flashing mechanism producing not more than 40 flashes per minute but not less than 12 flashes per minute with a period of darkness equal to one-half the luminous period. It is recommended that the frequency of flashes per minute be not less than 20 when the structure is less than two miles from the nearest boundary of a landing area to which the regulations apply.

The regulations also cover in detail the obstruction markings for various other structures.

Battelle to Have European Branch

Battelle Memorial Institute, Columbus, Ohio, the world's largest independent industrial research foundation, will soon establish a European branch of its laboratories to serve the European economy.

"The accumulated knowledge and experience gained through Battelle's service to American industry can do much to help industry in Europe increase its productivity and elevate the standards of living there," in the opinion of Dr. Clyde Williams, the Institute's director, who added: "At the same time, European science has much to offer American scientists, especially in the way of fundamental knowledge and research. By working together, research men of both continents will benefit from association with each other. We believe further that the establishment of an international research center will do much to promote world peace by encouraging understanding and friendship among scientists of all nations. We look forward to this opportunity to increase our service to mankind throughout the world."

Exact location of the European branch and other details will depend upon the outcome of negotiations now in progress. It is anticipated, however, that the new service will be in operation early next year.

The Columbus laboratories of Battelle have a staff of 1600 scientists, technologists and their assistants. This year they will conduct an estimated $9,000,000 worth of research for industry and government.

Corrosion of Electrical Equipment

The tremendous increase in electrification of industry in recent years has multiplied corrosion problems in control equipment, the American Institute of Electrical Engineers was told during its Pacific General Meeting at Portland, Oregon. Harold E. Springer, in a technical paper, pointed out corrosion of mechanical and current-carrying electrical apparatus works havoc in varying degrees in many industries, particularly those that manufacture or use chemicals in any form. Such industries include pulp and paper mills, cement and chemical plants. Corrosion also is likely to occur in plants near salt water, in mining operations and in wood cut-up plants. He recommended study of atmospheric conditions before installing or replacing electrical equipment; also selection of the right protective metals and dielectrics, protective painting and plating, and air conditioning when equipment is installed indoors.

Listed as various ways in which electrical equipment is made unreliable by corrosion were:

1. Overheating of contacts on starters, fuses and circuit-breakers.
2. Disintegrating of braided or twisted shunts, connecting studs and terminal screws.
3. Open circuits in fine wires of operating coils on control relays and contactors.
4. Sticking of relays, meters, instru-

high efficiency AEROTEC

DUST COLLECTORS

Partially erected collector showing inlet, outlet and dust discharge passages.

New Niagara-Mohawk Power Corporation Dunkirk Steam Station, equipped with Aerotec Dust Collectors.

assure your plant the same protection given the new

NIAGARA MOHAWK POWER CORPORATION

Dunkirk Station . . . and a duplicate Albany Plant

At the new Dunkirk Steam Station of Niagara Mohawk Power Corporation, two reheat steam generators of 670,000 lb. per hour capacity are pulverized fuel-fired. Dust collection for this station is handled by Aerotec, Design 3 RAS Collectors, and a duplicate system is under construction for the new Albany Steam Plant . . . making a total of eleven Niagara Mohawk boilers to be equipped with Aerotec Dust Collectors.

The collectors for Dunkirk and Albany consist of 84 "Unit Building Block" elements completely assembled at the factory for easy erection in the field. The small diameter tubes, of permanent molded aluminum construction, have proved their extremely high collection efficiency and long life on hundreds of installations. Their light weight cuts steel requirements for supporting structure, and makes possible roof installations with a minimum of reinforcement. The light weight tubes also reduce erection costs.

Aerotec efficiencies meet or exceed the requirements of most dust ordinances today. Evenly spaced tube outlets provide excellent inlet flow conditions for an AEROTEC electrical secondary—should future ordinances require still higher efficiencies.

Write for the new Design 3 RAS Catalog No. 601.

Project and Sales Engineers

THE THERMIX CORPORATION

GREENWICH, CONNECTICUT

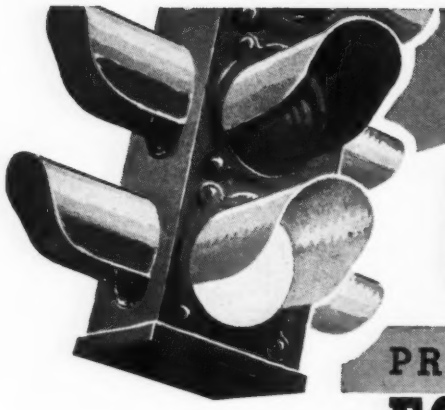
(Offices in 28 Principal Cities)

Canadian Affiliates: T. C. CHOWN, LTD.
1440 St. Catherine St., W., Montreal 25, Quebec • 50 Abell St., Toronto 3, Ontario

THE AEROTEC CORPORATION

GREENWICH, CONNECTICUT

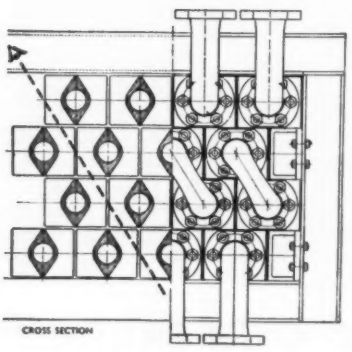
Manufacturers of mechanical dust collectors, electrical precipitators, air cleaners, industrial integral dust collectors, gas-oil scrubbers and dust reclaiming equipment.



GREEN

PREMIER DIAMOND ECONOMIZERS

The Economizer with the "Diamond" Design



Here are the four major values in the "diamond" shape of the Green Fuel Economizer:

1...Streamline flow of flue gases gives minimum draft loss

2...Finned tubes give maximum heating surface in given space

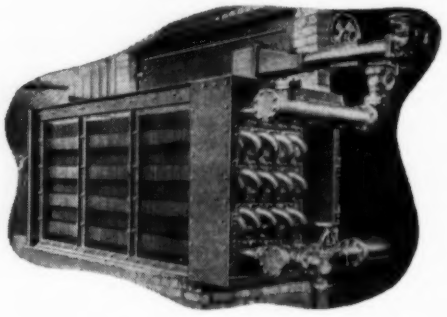
3...Staggered tube arrangement permits easy inspection

4...Minimum soot collecting surface is thoroughly cleaned by Green's "Special" Soot Blowers

Green Premier Diamond Economizers are available in either cast iron tube construction (Type 25) or steel tube construction (Type 12).

Pressure parts are rugged and joint flanges independent of support flanges.

Green Fuel Economizer's reputation of 60 years assures you of satisfactory performance and quality. Send for Bulletin No. 169.



THE GREEN Fuel Economizer COMPANY INC.

BEACON 3, NEW YORK

ECONOMIZERS • FANS • AIR HEATERS • CINDERTRAPS

ments, control buttons, rehostats, solenoids and controllers.

5. Rusting away of apparatus enclosures, conduits, meter frames, ball bearings, transformer cases and line hardware.
6. Failure of power circuit-breakers to trip or close.
7. Grooving and burning of commutators and collector rings.
8. Insulation failures on motor windings and coils of various types.
9. Flashover of porcelain bushings.

Where feasible, air conditioning is effective in protecting electrical apparatus, Mr. Springer said. In air conditioned rooms standard apparatus will give good reliable service. Maintenance is reduced to a minimum, paint jobs last longer, temperatures are easily controlled, and workmen take more interest in proper handling of equipment. Dirt, another enemy of electrical apparatus, does not accumulate so rapidly and what does enter is more likely to be removed by maintenance men. Even the improved morale among operators and maintenance men resulting from these better conditions is not to be overlooked.

Lignite Laboratory Dedicated

On September 29 Secretary of the Interior Oscar L. Chapman officially dedicated the Charles R. Robertson Lignite Research Laboratory of the Bureau of Mines at Grand Forks, N. Dak. This new laboratory, designed to solve problems arising from the development of large domestic reserves of recoverable lignite, estimated at 355,725,000,000 tons, is named after the late Congressman Charles R. Robertson who initiated and guided the legislation which led to its establishment.

The new laboratory, which is on the University of North Dakota campus, contains a pilot plant for large-scale experimental work, and an administrative-laboratory wing with 27 well-equipped individual laboratories. Lignite studies have been conducted by the Bureau of Mines in cooperation with the University for many years, the research now in progress dealing with preparation, chemistry, drying, gasification and other studies, all of which may eventually mean greater industrialization and a new era of prosperity for the Great Plains and nearby states.

The Bureau of Mines gasification pilot plant, which began operations in 1945, and last week completed its eighteenth test run, has produced to date a total of about 85,000 cubic feet of gas. Known as water or blue gas, this could be used to heat homes or serve as fuel for power plants, make synthetic liquid fuels, reduce Minnesota iron ore, manufacture ammonia for fertilizer for agricultural use, and for the hydrogenation of vegetable oils and fats.

Of the nation's recoverable lignite reserves, North Dakota contains nearly 300,000,000,000 tons, Montana nearly 44,000,000,000 tons, and Texas nearly 11,500,000,000 tons.

Symposium on Boiler Instrumentation

The Philadelphia section of the Instrument Society of America is sponsoring a symposium on boiler instrumentation to be held on Thursday, November 15, 1951, at the Bellevue-Stratford Hotel, Philadelphia. This will be an all-day conference with representatives of both instrument manufacturers and users presenting technical papers and discussions on various phases of this subject. Technical chairman of the symposium will be A. W. Thorsen, supervising engineer, United Engineers. The program which will commence about 9:30 a.m. includes the following papers:

"Design of Instrumentation and Control in a Modern Power Plant" by T. Y. Mullen, Engineering Department, Gilbert Associates, Inc.

"What the Boiler Designer Expects of Instrumentation" by H. C. Mittendorf, chief electrical engineer in charge of control design, Combustion Engineering-Superheater, Inc.

"Type of Combustion Control—Superheat and Reheat Controls" by E. D. Scutt, in charge of steam power section, Leeds & Northrup Company.

"Modern Feedwater Control" by C. H. Barnard, application engineer, Bailey Meter Company.

Each paper will be followed by prepared discussions by selected manufacturers and users.

At an evening session starting at 8 p.m. Mike Boho of Hagan Corporation will talk on the subject of "Instrumentation for the Power Plant of the Future." The Industrial Instruments and Regulators Division of the ASME has been invited to attend and all guests interested in the general subject will be most welcome. A registration fee of $2.00 per person will be charged for the morning and afternoon sessions; registration starts at 8:45 a.m. A cocktail hour, open to all registrants, is planned to follow the afternoon session.

Group Formed to Study Insulation

Approximately a hundred engineers interested in heat insulation have organized "The Thermal Insulation Society," the first president of which is W. H. Zane, duPont engineer and vice chairman of the A.S.T.M. C-16 committee on insulation specifications. This new group will meet once a month at the Franklin Institute, Philadelphia, to discuss common problems and to hear an outstanding speaker on some specific insulation material.

Membership is open to men interested in insulation from the manufacturing, application, specification, distribution and end-use viewpoints. Leading industrials in the greater Philadelphia area are represented. By accumulating information gathered by these various groups the society plans to serve a long recognized need for insulation specifications based on a broad knowledge of engineering, theory and practice.

138-I

BETWEEN TWO FIRES

Boiler steel meets "fire" on *both* sides of tubes and drums. Just as flame, in consuming fuel, tends directly or indirectly to cause deterioration of fire-side boiler steel, so water, too, reacts with metal — less obviously, perhaps, but nonetheless surely — for water is and always will remain a chemical, potentially destructive to steel.

Recognizing this fact, operators of boilers large and small — in central stations, industrial plants, aboard ship and on the railroads — apply a protective coating of Apexior Number 1 to all steam and boiler-water-exposed metal.

Apexior helps retain for the life of any boiler the advantages of new or newly cleaned metal. It grips steel with a hold never released in normal boiler operation. Impervious to moisture, it ends water-metal contact — repels deposits, too, by adding a surface so smooth it denies them a footing.

Thus Apexiorized metal remains sound — stays in service longer. Free from heat-transfer barriers, it puts b.t.u.'s to work more efficiently. In a word, *better* boiler performance — and more of it — is the return Apexior gives you on a truly modest investment.

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THE DAMPNEY COMPANY

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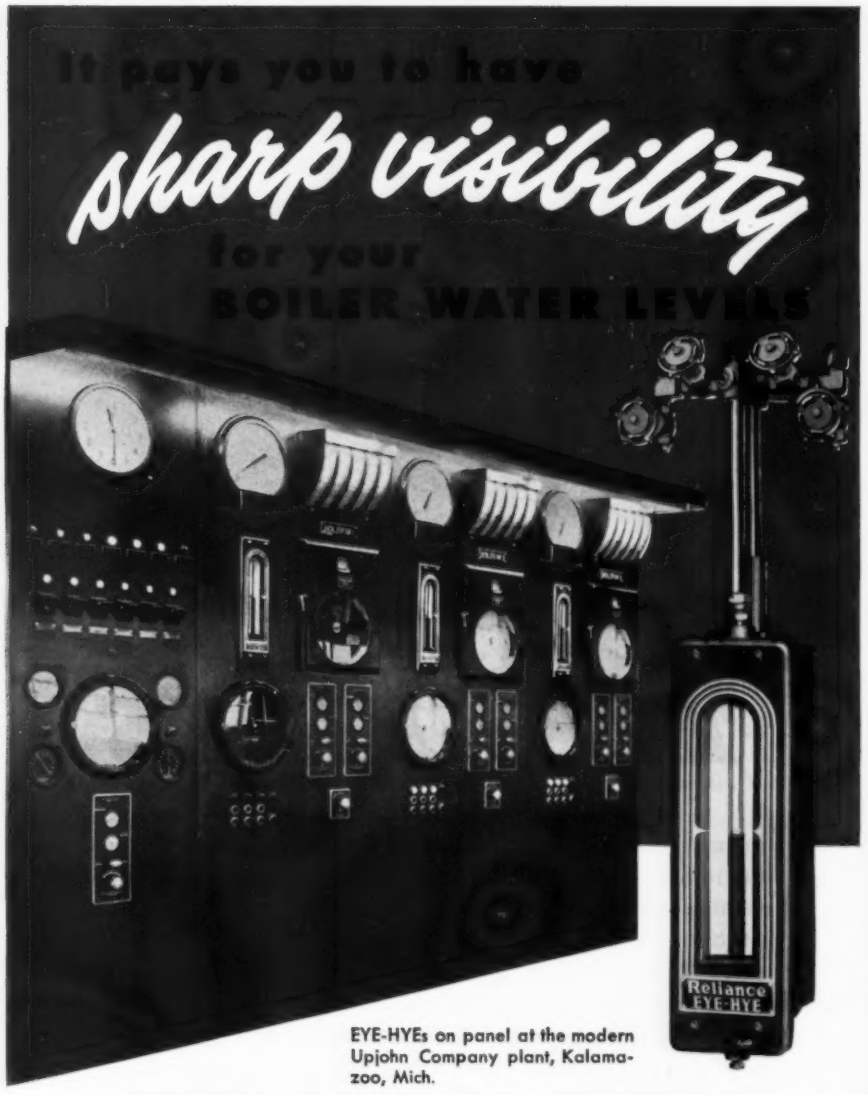


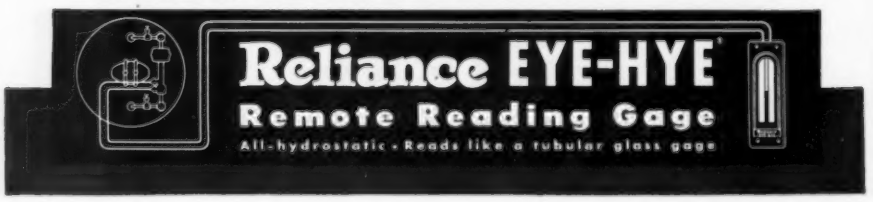
EYE-HYEs on panel at the modern Upjohn Company plant, Kalamazoo, Mich.

EYE-HYE Remote Reading Gage Saves Time–Increases Safety

● Clear, mistake-proof reading of water gages right on your instrument panel, or wherever you want it—that's the modern way to get adequate supervision of vital boiler water. EYE-HYE brings an accurate reading to eye-height at control stations—shows water level in a liquid column, like a tubular gage. But its image is sharper, easier to read. Reliance VIZZENE, a special green liquid, brightly illuminated from behind represents the water level.

EYE-HYE is all-hydrostatic—is as simple as a manometer. It has no mechanical working parts—is calibrated at the factory for the individual boiler for which it is ordered. No adjustments or tampering possible on location. Easy to install—easy to maintain. Write for evidence of thousands of satisfied users.

The Reliance Gauge Column Co., 5902 Carnegie Avenue, Cleveland 3, Ohio



Business Notes

Midwest Piping & Supply Co. has appointed John E. Brock as director of research with headquarters at its main plant in St. Louis. Mr. Brock was previously engaged in ceramic research for Westinghouse and subsequently was associated with the Union Electric Co. and the Missouri Laboratories.

Graver Water Conditioning Co. has appointed Harold R. Fosnot eastern sales manager with headquarters at the home office in New York. Herman M. Ross replaces him as district manager in Chicago and, in turn, is replaced in Cleveland by Richard E. Lewis.

Baldwin-Hill Co. announces the appointment of J. L. Mohun as division manager for industrial insulation sales at a new sales office in Houston, Texas.

The Swartwout Company, Cleveland, has opened a new sales office in the M & M Building, Houston, Texas, where J. B. Downey will handle power plant and process control equipment and W. A. Sharp roof ventilator sales and service.

Edward Valves, Inc., has moved its Pittsburgh sales office to the Investment Building, 235 Fourth Avenue. It will continue under the supervision of T. E. Skilling, district sales engineer.

Dowell Inc., Tulsa, Oklahoma, has promoted Claude H. Groom to assistant sales development manager. Other recent appointments include Roy Bostick as sales development engineer; James Reed development engineer in service and product development; P. S. Clinkenbeard and Dale Benefield, district sales engineer and sales engineer at Shreveport, Louisiana; as well as a number of promotions in the Edmonton, Canada, office.

Flexitallic Gasket Co., Camden, New Jersey, has added six new agents and one new distributor to its field organization. The agents include Jno. D. Hiles Co., Pittsburgh; Engineering Products Co., Charleston, W. Va.; Chapman Engineering Sales Co., Cincinnati, Ohio; De Haven Engineering Co., Indianapolis, and Energy Control Corp., Philadelphia. The new distributor is Fleck Bros., Ltd., of Vancouver, B. C.

General Electric Co. has formed six new divisions: Turbine, Motor and Generator, Transformer and Allied Products, Measurements and Industrial Products, Switchgear and Control, and Component Products.

L. J. Wing Mfg. Co., Linden, N. J., whose unit heater line has long been handled in western New York by the Stone Company of Rochester, announces that this company will henceforth handle its complete line of products in that territory.

Johns-Manville Corp. has named Don L. Hinmon assistant manager of its Transite Pipe Department. Mr. Hinmon has been associated with the company since 1936 and succeeds E. A. Phoenix, who becomes manager of market surveys.

Allis-Chalmers Mfg. Co. has combined its Electrical and Mechanical Power Departments into a Power Department under the management of J. L. Singleton, who had previously headed the Electrical Department. He will be assisted by F. W. Bush in charge of the electrical sections, C. C. Jordan, the mechanical sections, and R. N. Miers, steam turbines.

Standardized Steam Plants

REA borrowers will soon be building completely standardized steam plants and already are purchasing the main items of equipment according to standard specifications. Its electric distribution line standardization was a major factor in reducing construction costs at the outset of the program, and standardization of steam plant construction is expected to have a similar result. It is claimed that by carefully arranging equipment in a steam power plant and providing space for operation that is ample but not wasteful, the cubic content of the building can be cut to about half of that which is often used.

For the past year, William P. Dryer, consultant to the Steam Plants Section of REA's Power Division, has been developing the standards for steam power plants. By this means it is anticipated that both money and materials will be saved in construction, without sacrificing plant efficiency.

The first step taken was standardization of the heat cycle for 16,500 and 22,000-kw units while designs for 33,000 and 44,000-kw units are under way.

Boiler standardization plans are still being worked out although the variation in fuel and methods of firing impose some difficulties. Preliminary layouts for boiler plants have already been drawn, based on information obtained from boiler manufacturers.

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Designed to your specific requirements.

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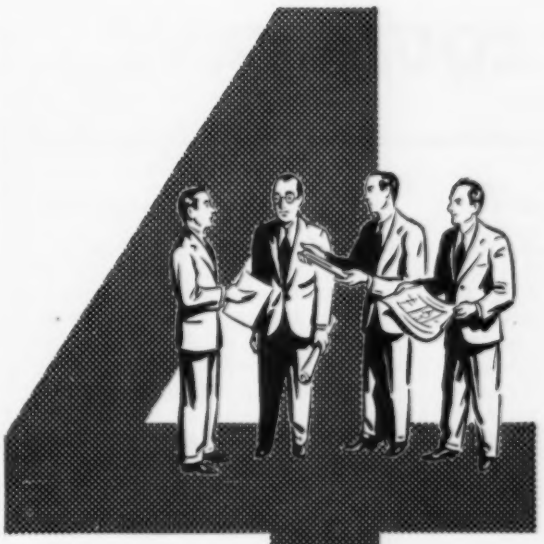

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The Fairmont Coal Bureau's cooperative market development program has reduced steam costs in many plants, for example:

Plant "A" producing 35,000 lbs. of steam per hour—fuel savings $41,300.00 per year.

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Fairmont Coal Bureau engineers have the facts and figures on hundreds of plants. This "Know-how" applied to your problem might result in savings similar to the case histories shown above. Mail coupon below today, or give us details on your particular steam production problem.

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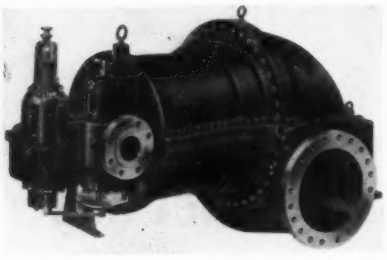
NEW EQUIPMENT

Mechanical-Drive Turbines

A newly designed line of multi-stage, mechanical-drive turbines in ratings from 200 to 5000 hp has been announced by General Electric's turbine department, Schenectady 5, N. Y. The Type DP turbine which has a top rating of 3000 hp is equipped with a hydraulic governor to provide a 30 per cent speed range and 6 per cent regulation. The Type DR turbine,



rated up to 5000 hp, is built for applications requiring a wider speed range (up to 6 to 1) and greater accuracy of control. Automatic sectional valves instead of a single governer-controlled valve are used on the Type DRV turbine. All three of these units may have from two to ten stages, depending upon steam conditions and type of service. A fourth type, DRVX, has a single extraction stage, the pressure of which is held constant when the load on the unit fluctuates.

Valve Handle

Edward Valves, Inc., of East Chicago, Ind., has developed a cross-arm handle incorporating the Edward Impactor handwheel principle. This means for exerting greater effort to insure positive valve closing against high operating or test pressures is said to deliver 2.8 times the closing force of regular handwheels. The handle is applicable to $1^1/_4$, $1^1/_2$ and 2-in. valves for pressures of 1500 and 2500 psi. In operation, two lugs of the cross-arm handle strike equal blows simultaneously against the opposite sides of an adapter attached to the valve stem.

Capacitor Motors

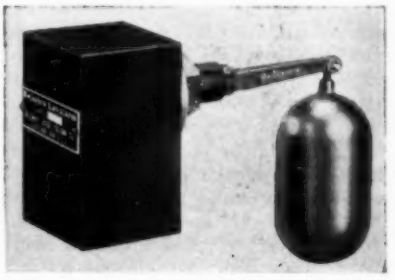
New vertical solid-shaft capacitor motors, featuring standardized mounting dimensions and quiet operation, have been announced by General Electric's Small and Medium Motor Divisions, Schenectady 5, N. Y. The motors, which are included in the Tri-Clad integral-horsepower, single-phase motor line, are available in ratings from $^3/_4$ to 5 hp.

Flow Signal Transmitter

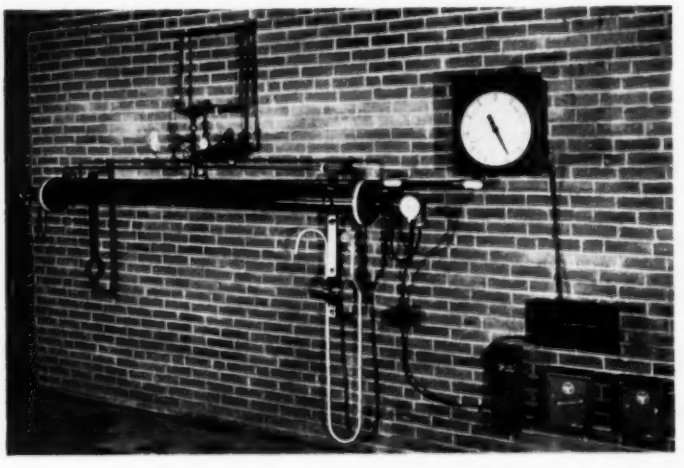
A pneumatically operated flow differential measuring unit known as the High Pressure Flow Signal Transmitter is announced by the Hagan Corporation, Hagan Building, Pittsburgh 22, Pa. It is capable of transmitting proportional signals to remote recording or indicating instruments or to automatic control units. Typical applications include steam output of boiler, superheater or economizer; feedwater flow to boiler; liquid flow through pumps; liquid fuel flow to burners; and differentials resulting from changes in liquid level in open or closed vessels. Interchangeable measuring elements cover a continuous range of pressure differential from 5.5 in. water gage to 100 psi, at static pressures up to 1500 psig. Accuracy of measurement is within one per cent of full scale reading. When sending maximum loading pressure a change of only 0.1 per cent in applied pressure differential will effect a reproducible change in loading pressure.

Signal Switch

A float-operated signal switch device or fuel cutoff designed to operate on pressures from vacuum to 450 psig is announced by Reliance Gage Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio. Designated as Levalarm EA-10, the unit can be used as a signal switch to set off warning



signals such as bells, sirens or lights when liquid levels in small boilers or various types of tanks reach predetermined high or low points. In conjunction with water columns the float lever is inserted into the alarm valve opening. The Levalarm can then be used as a fuel cutoff for low water.



Gas Analyzer and Alarm

General Power Plant Corp., 381 Fourth Ave., New York 16, N. Y., has developed a blast-furnace gas analyzer and alarm to meet steel-mill requirements in supervising blast furnace gas. It provides a continuous record of the dust in the gas and has an alarm to advise the operator when the dust concentration exceeds allowable limits. The gas sample is introduced into the center of the main tube shown in the illustration and flows either way to the exhausts where it is burned. In this photoelectric-type analyzer the gas velocity is maintained high enough to keep the dust in suspension and to keep the sample typical of the gas flowing in the gas main at the time the sample is recorded.

The recorder incorporates a special electronic circuit that measures the difference in output between two photronic cells. One cell receives the light directly from the energizing lamp, while the second cell receives its light through the gas being analyzed. The instrument is set at zero by adjusting the circuit so that the output of the two photronic cells is equal when the sampling tube is filled with clean air. The recorder must be calibrated for each type of gas and for each setting of the sampling tube. The calibration is accomplished by measuring the actual solid content of the gas.

The present installation which analyzes blast-furnace gas has been in service since September 1950. The same type of equipment can be adapted for the determination of the amount of fly ash in pulverized-coal firing.

NEW CATALOGS AND BULLETINS

Any of these may be secured by writing Combustion Publishing Company, 200 Madison Avenue, New York 16, N. Y.

Adjustable-Speed Magnetic Drive

A 32-page technical bulletin entitled "Precision Speed Control with the Adjustable-Speed Magnetic Drive" has been made available by the Electric Machinery Mfg. Co. This exceptionally informative bulletin, Publication 1107, contains information on both the magnetic drive and the new magnetic amplifier Regutron speed control. Power plant applications are shown in a series of photographs of forced and induced-draft fans equipped with magnetic drives.

Purifiers

A four-page bulletin issued by The Centrifix Corp. illustrates and describes functions of nine types of purifiers for entrainment separation in air, steam, vapor and gas applications in power generation, petroleum refining and process industries. Among the applications described are upflow and downflow purifiers for boilers.

Chemical Pumps

Warren Steam Pump Co. has made available a four-page, two-color bulletin devoted to the Type G pump for process and medium-duty chemical services. The bulletin includes specifications, dimensions, selection chart and external and sectional views for these pumps which may be obtained in capacities up to 400 gpm and heads to 240 ft.

Forced-Draft Fans

The Prat-Daniel Corp. is offering an eight-page illustrated bulletin, No. 300, describing design features of a new series of forced-draft fans. The booklet shows various types of fan wheels equipped with backward-curved blades and pictures several different kinds of housing.

Blowers and Compressors

A most attractive and useful 52-page bulletin on centrifugal blowers and compressors has been published by the De Laval Steam Turbine Co. It describes and illustrates single and multistage units with capacities ranging from 1000 to 150,000 cfm. Sections of the bulletin are devoted to application data, design and construction, steam-turbine and motor drives and engineering data including examples for computing compression of gases and pipe friction.

Induction Motors

Construction features of large end-shield bearing squirrel-cage induction motors are described in a six-page bulletin, No. 05B7542A, issued by Allis-Chalmers Mfg. Co. The bulletin shows photos of assembly details and a table of ratings up to 1750 hp at 1800 rpm.

Welding of Nickel

A new technical booklet on the resistance welding of nickel and high-nickel alloys has been issued by the Development and Research Division of The International Nickel Co., Inc. Designated as Technical Bulletin T-33, it contains 32 pages illustrated throughout by drawings and photographs. It also presents tables on mechanical properties, chemical compositions, recommended conditions for welding and other information.

Paper Mill Power Equipment

A 16-page bulletin describing power system equipment for pulp and paper mills is now available from the General Electric Co. Designated as publication GEA-5521 and illustrated with 26 photos and diagrams, the bulletin features a discussion of types of turbine-generators suitable for paper mills. The advantages of modern load-center systems are also mentioned.

Plant Modernization

An eight-page case history telling of the modernization and expansion of the boiler room of Falstaff Brewing Company's Plant No. 5 is now available from The Hays Corp. New equipment added, building changes and uses for steam are described. The operation of the combustion control system is explained in the text and accompanying photos and schematic diagrams.

Ion-Exchange Materials

Bulletin 57 prepared by the National Aluminate Corp. covers Nalcite SAR, a strongly basic anion exchanger. The 16-page bulletin discusses physical properties, stability, backwash expansion data, exhaustion cycle, regeneration, and silica removal. The various properties are illustrated by graphs, and sample calculations are given.

Blow-off Valves

Up-to-date information on Yarway blowoff valves for pressures up to 400 psig is given in a 22-page bulletin, B-425, issued by the Yarnall-Waring Co. Construction details and typical dimensions are given for Types A and B seatless valves and for double-tightening valves.

Control System

The Swartwout Co. has published a four-page bulletin, A-701, on the new Swartwout Autronic control system. Printed in two colors and illustrated with photographs, line sketches, dimensional drawings and a schematic diagram showing principles of operation, the bulletin describes the Autronic system as the first miniature all-electronic system for controlling pressure, temperature, flow and level. Its principal uses are in chemical processing plants, refineries and central stations.

Water Hammer

The cause, effect and control of water hammer in piping systems are considered in an eight-page bulletin, No. WH-851, published by the Williams Gauge Co. The brochure indicates the potential damage to piping, instruments and other parts of water systems and considers methods of controlling water hammer. Curves representative of several hundred tests showing the intensity, action of the pressure wave and the origin of water hammer are shown. Findings reported are believed applicable to many liquids.

Conveyor Idlers

Bulletin 51-81 prepared by the Chain Belt Co. contains information on the latest designs of belt-conveyor idlers and machinery. A detailed description of zipper bunker seals is included along with data on belt-conveyor trippers. There are two pages of general engineering design information and a section on maintenance procedures in the 42-page bulletin.

Manifold Discharge Piping

A 34-page manual, 51-B, has been published by the Farris Engineering Corp. under the title, "Principles of Manifold Discharge Piping Application with 'Farri-Seal' and 'BalanSeal' Safety-Relief Valves." It proposes an approach to the design of discharge header systems for refineries based upon the partial or complete elimination of back-pressure effects on tied-in safety-relief valves. Among the subjects discussed are valve sizing with collecting systems and design of discharge piping. Test data and engineering charts are included.

Adjustable Pipe Hangers

The Power Piping Division of Blaw-Knox Construction Co. has prepared an elaborate and useful catalog, No. 51, on adjustable pipe hangers, vibration eliminators and supports. The first section is concerned with Blaw-Knox functional-type spring hangers and vibration eliminators. Other fixtures described are pipe attachments, anchors, brackets, and tunnel supports. A valuable technical section includes specifications for pipe hang-

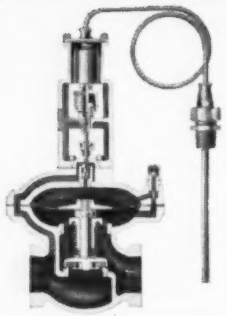
GOOD TEMPERATURE REGULATION MEANS FEWER HEADACHES

In Power Plants all over the world, you will find Foster Temperature Regulators controlling temperatures of liquids and gases on heating and cooling equipment such as fuel-oil heaters; storage type water heaters, evaporators and cooling systems. The reason for this acceptance is that they offer a simple, dependable answer to accurate, automatic temperature control. They do their job well, with a minimum of maintenance.

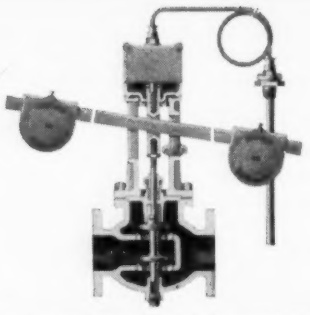
The Foster line of Temperature Regulators is also good news for plants where ovens, dryers, cookers, coolers, pasteurizers and similar types of equipment are extensively used. By controlling temperatures accurately, they help the uniformity of materials in process and often save fuel. They can be furnished with casing wells so that thermal units can be replaced without lowering liquid level of vessel.

Foster Engineers are competent to work with you to get the right type of regulator for your own specific needs.

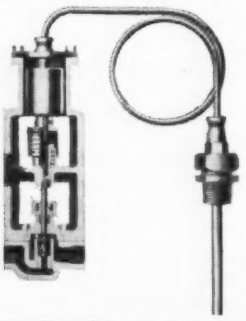
Here are 4 typical Temperature Regulators in the Foster Line of more than 8 standard types.



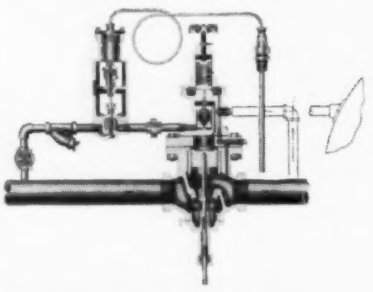
The Foster Type 34-T controls temperatures within approximately 1° F plus or minus, using steam or gases as heating medium. Internally pilot-operated, diaphragm actuated; valve travels from shut-off to full opening with relatively small temperature change.



The Foster Type T-3 controls temperatures within 3° to 5° F, plus or minus, using steam, water or other liquids and gases as heating or cooling medium. Handles large volumes with low pressure drop across double seats.



The Foster Type T-4 controls temperatures within plus or minus 5° F, using small volumes of steam, water or other liquids or gases as heating or cooling medium. Direct-acting, single seated for tight shut-off.



The Foster Type T-10 combination temperature and pressure regulator permits safe use of steam at pressures considerably higher than the shell of the heated vessel is built to withstand. Adjustable for both temperature and pressure.

FOSTER ENGINEERING

PRESSURE REGULATORS . . . RELIEF AND BACK PRESSURE VALVES . . . CUSHION CHECK VALVES . . . ALTITUDE VALVES . . . FAN ENGINE REGULATORS . . . PUMP GOVERNORS . . . TEMPERATURE REGULATORS . . . FLOAT AND LEVER BALANCED VALVES . . . NON-RETURN VALVES . . . VACUUM REGULATORS OR BREAKERS . . . STRAINERS . . . SIRENS . . . SAFETY VALVES . . . FLOW TUBES

ers and supports, typical hanger problems weight of piping materials and a synopsis of the method for designing piping with Flex-Anal charts. Engineers who are responsible for writing piping specifications and purchasing related materials will find this 96-page catalog of considerable use.

Testing Instruments

Bulletin GEA-5469 issued by the General Electric Co. is a 16-page buyer's guide for testing instruments. It includes illustrations, features and suggested prices of hook-on volt-ammeters, watt meters and power-factor meters; portable electrical recording and indicating instruments; and apparatus to measure magnetic fields, welding cycles, viscosity and roughness.

Magnesia Insulation

A two-color, eight-page bulletin (4h) describing 85 per cent magnesia insulation and other insulating products has been released by Ehret Magnesia Mfg. Co. It presents characteristics and advantages of Thermalite 85 per cent magnesia and includes tables showing recommended insulation thicknesses for various temperature ranges. Application procedure for various sizes of piping and for indoor and outdoor service is explained.

Nickel Alloy Pipe

Fabrication and design of nickel and high-nickel alloy pipe and tubing is discussed in a 27-page technical booklet issued by the Development and Research Division of The International Nickel Co., Inc. Bulletion T-17 presents tables on mechanical and physical properties, ASME code requirements, recommended welding procedures and other information.

Draft Instruments

A functionally designed, fully indexed 20-page bulletin on the Hays Corp. line of draft and low-pressure instruments is now available. It discusses seven types of indicators as well as recorders and controllers. A two-page application table is included to aid in the selection of the correct instruments for specific conditions. Size, scales, ranges and cases of each instrument are illustrated and discussed.

Carbon Brushes

Publication GEA-5597 of the General Electric Co. provides application information and recommendations for carbon brushes for electric equipment. A table of brush grades covers the properties of carbon graphite, electrographitic, graphite and metal graphite brushes. Another section of the 26-page bulletin is devoted to mechanical design of brushes.

Rotary Pump

Warren Steam Pump Co., Inc., has made available an eight-page bulletin, WQ-50, covering Warren-Quimby Rotex pumps. The bulletin illustrates and describes in detail an improved rotary type of pump, including both sectional and exterior views, dimensions, selection chart and specifications.